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PROFESSIONAL PILOTS METEOROLOGY TRAINING STANDARDS CONFERENCE: FINAL REPORT

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Captain Timothy H. Miner, USAF

JULY 1989



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THE PROFESSIONAL PILOTS' METEOROLOGY TRAINING STANDARDS
CONFERENCE: FINAL REPORT

APRIL 13-14, 1989

UNITED STATES AIR FORCE ACADEMY, COLORADO

SPONSORED BY

THE DEPARTMENT OF ECONOMICS AND GEOGRAPHY
UNITED STATES AIR FORCE ACADEMY, COLORADO 80840-5701

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INTRODUCTION AND BACKGROUND TO THE PROFESSIONAL PILOTS'
METEOROLOGY TRAINING STANDARDS CONFERENCE

The Professional Pilots' Meteorology Training Standards Conference occurred April 13-14, 1989 at the United States Air Force Academy. This conference attempted to identify a complete list of learning outcomes in meteorology studies that would apply to all professional pilots. It also provided an opportunity for pilots and meteorologists from the civilian and military communities to discuss issues that affect both groups. While the planning for this conference began in January 1989, the environment that precipitated the conference was a long time in the making.

The Federal Aviation Regulations (FARs) are not specific about the kinds of information that pilots are required to know about meteorology. This condition led to confusion about what exactly should be taught and what exactly should be learned about meteorology to be a safe and competent pilot.

The regulations for weather training for the student pilot apply to cross-country flights. The student pilot must know the "recognition of critical weather situations, estimating visibility while in flight, and the procurement and use of aeronautical weather reports and forecasts" (61.93blv).

The private pilot is required only to know the "recognition

of critical weather situations from the ground and in flight, the procurement and use of aeronautical weather reports and forecasts" (61.105a3).

The instrument rating requires the pilot to know only "the procurement and use of aviation weather reports and forecasts, and the elements of forecasting weather trends on the basis of that information and personal observation of weather conditions" (61.65a3).

The commercial pilot must know "meteorology, including the characteristics of air masses and fronts, elements of weather forecasting, and the procurement and use of aeronautical weather reports and forecasts" (61.125b3). It is important to note that this only applies to rotorcraft--there is no requirement for the airplane pilot.

The airline transport pilot must know, according to 61.153a, "(c) the general system of weather collection and dissemination; (d) weather maps, weather forecasting, and weather sequence abbreviations symbols, and nomenclature; (e) elementary meteorology, including knowledge of cyclones as associated with fronts; (f) cloud forms; (g) National Weather Service Federal Meteorological Handbook No. 1, as amended; (h) weather conditions, including icing conditions and upper-air winds, that affect aeronautical activities; (j) information from airplane weather observations and meteorological data reported from observations made by pilots on air carrier flights; and (k) the

influence of terrain on meteorological conditions and developments, and their relation to air carrier flight operations.

Since these regulations only list general topics for the pilot to know, they create confusion about what specifically should be taught and even tested to insure a safe and competent pilot at the various levels.

The requirements for all pilots training at the United States Air Force's Undergraduate Pilot Training programs are more specific. However, this curriculum in weather is limited to twenty-five specific objectives (Appendix A1) that require about 16 hours of classroom time. The pilot candidate devotes half of these 16 hours to the use of a computer-based learning system with limited graphics capability, while the other half of that time is classroom instruction from a young instructor pilot. Because the amount of weather instruction is about one-third what used to be taught, and because the other military service programs spend about double the training time, it begs the question about the validity of the current training program.

Other groups recommended a change to pilot meteorology training. In 1986 the National Center for Atmospheric Research, NCAR, published a report that recommended changes to the aviation weather system. NCAR is a research organization sponsored by the National Science Foundation and 58 universities with docorate programs in atmospheric science. The FAA sponsored NCAR's report

titled Aviation Weather Forecasting Task Force: Final Report. In this study three of the twenty recommendations for change directly affected pilots.

Recommendation number five states, "Improve pilot education regarding the standardized language of PIREPs." The task force published several insights on pilots and PIREPs. They found that pilots "do not bother" with PIREPs. "Pilots find it difficult to make PIREPs" while engaged in IFR flying. "PIREPs are sometimes rendered useless or misleading by non-standard pilot descriptions of the phenomenon." Finally, the FARs don't require PIREPs anyway. According to the Aviation Weather Task Force, pilots need to be educated on the importance and critical role PIREPs can play in the gathering of weather information. They also had suggestions for controllers, FSS personnel, and "the system" that collects, distributes, and reports PIREPs.

Recommendation number seventeen states, "Upgrade the weather portion of airman exams." The task force made several observations to justify this requirement. The task force felt that current FAA minimums for weather knowledge are "inadequate", and that "not all pilots are as well trained in aviation weather as their ratings require." They felt that there were significant problems with the FAA's weather-related questions which were "simplistic, vague, and qualitative." These questions failed to test the student's abilities to "distinguish between incidental and truly hazardous weather encounters, and their ability to

assess quantitatively the impact of a particular weather encounter on the aircraft operations." The task force felt that the present system of testing allowed a pilot to go from private to ATP ratings without passing a single question related to weather. These weather experts also felt that FAA questions are based on old and outdated meteorological knowledge and that they are so poorly written and simplified that a truly knowledgable person would probably miss the questions anyway. Finally, the task force felt that most pilot oral exams and pilot flight reviews fail to examine weather-related issues--especially with instructors and examiners "who themselves have a limited background and experience in meteorology" and its impact on aircraft operation.

Because of these dificiencies, the twentieth and final recommendation called for the development of "impact-oriented training and exams to provide pilots with more in-depth preparation for diverse weather situations." This training would use "cause-and-effect weather training" with the latest weather research. NCAR published these recommendations in 1986, but little was done with them.

In January 1989, the American Meteorological Society sponsored the Third International Conference on the Aviation Weather System. Held every three years, these conferences are filled with meteorologists presenting the latest research on forecasting techniques, new equipment for gathering and analyzing

data, and related issues. Pilots, the whole reason for the aviation weather system, were the focus only during the first day at the keynote presentations, during a session three days later which concentrated on training issues, and during the final session where information systems were discussed. It was the keynote addresses that had the greatest impact on those who were pilots.

During the opening session there were five different speakers including Dr John McCarthy, chairman of the Aviation Weather Forecasting Task Force; Captain Patrick Clyne of Northwest Airlines and chairman of the Airline Pilots Association Aviation Weather Committee; a member of the National Transportation Safety Board; and two others. Several speakers mentioned that forty percent of all fatal aircraft accidents have weather as one of the major contributing causes. Each speaker stated that "pilots don't know enough about meteorology." Unfortunately, no speaker mentioned just what it was that pilots don't know that they should.

During this conference in Anaheim, several individuals made plans to define, once and for all, what it is that pilots need to know about meteorology. This was the genesis of the Professional Pilots' Meteorology Training Standards Conference. To accomplish this goal, as many groups as possible from the aviation and weather communities received requests to participate. Because it was critical that this be a joint effort between pilots and

meteorologists then, whenever possible, someone from both areas needed to represent each organization.

There were only two organizations that formally declined participation. These organizations were the airmanship training branch of the FAA, who felt that there was no problem, and the Airline Transport Association. All other organizations invited sent a representative or had a proxy there. These organizations paid for the expenses of their own participants.

This was the background that brought about the Professional Pilots' Meteorology Training Standards Conference at the United States Air Force Academy. This is the environment for pilot meteorology training that the group hoped to change.

National Center for Atmospheric Research, Aviation Weather Forecasting Task Force: A Final Report, Boulder CO: National Center for Atmospheric Research, 1986.

Federal Aviation Administration, FAR-AIM 1988, Seattle: ASA Publications, Inc., 1988.

POSITION PAPERS FROM ATTENDEES

Attendees to the Professional Pilot's Meteorology Training Standards Conference submitted position papers prior to the conference. These papers represent various conditions and research efforts that are currently on-going related to pilot meteorology training.

The first three papers are the keynote presentations made by representatives from the military, civilian, and from the academic programs. Colonel George L. Frederick, Jr., commander of the 3rd Weather Wing, was the military presenter. Mr Robert J. Massey, flight officer from Pan Am Airlines and the current chairman of the Aviation Weather Committee of the Air Line Pilots Association, made a presentation on the current status of the professional pilot in the civilian flight industry. Professor Frank Wencel, from Embry-Riddle Aeronautical University, made a presentation on the current status of meteorology training at civilian university flight programs.

Other attendees received the opportunity to describe the status of pilot meteorology training at other programs through a short paper. These papers are presented in alphabetical order of the authors.

U.S. AIR FORCE MILITARY AIRCREW WEATHER TRAINING

BY

COLONEL GEORGE L. FREDERICK, JR.

COMMANDER, 3D WEATHER WING

This paper will cover military aircrew weather training as practiced in the U.S. Air Force in previous years, as it exists today, some of the plans we have for tomorrow and some of the needs that exist in the aircrew weather training arena. Weather training programs in the Army and Navy vary significantly from the Air Force and are not treated here.

The tremendous buildup of military aviation before and during World War II generated increased requirements for weather training for aircrews. In many cases, WWII type aircraft operated in the weather a great deal of the time. Certainly in the European theater of operations, weather had a great impact on military activity--in particular aviation. As a result of WWII experience, weather training for new pilots in undergraduate pilot training, was extensive. In many cases, pilots received almost as much weather training as weather officers. Upwards of 45 to 60 hours of formal weather training was provided right up to the Vietnam War era. In the post Vietnam period, with the drawdown of the military services, we also saw a major change in training--particularly the formal weather training that our aircrews received. There were a lot of reasons for this and we could speculate about that. Some might say that the pilot training locations are in a relative weather free area of the country or that pilot training is mostly conducted in VFR conditions and therefore, there was less of a requirement for weather training. Others would point to increasing requirements placed upon the training organization to incorporate other aspects of flight training into the existing time period for training a new pilot. Over the years, the budget cycle has influenced the amount of practical experience that our pilots have in operating in all types of

weather conditions. With the restricted budgets we have today, flying time is very precious and there's a lot of training that needs to be crammed into that flying time. Very often weather conditions get in the way of that type of training. Certainly the advent of simulators in the post Vietnam era have reduced the visible requirement for formal weather training.

This leads up to today, where the bulk of the formal weather training is in our undergraduate pilot training program. It currently consists of roughly 15 to 16 hours of combined platform and computer aided instruction. The weather program is taught by a rated pilot as opposed to a weather officer as it had been in the past and the limited amount of time available for formal training is devoted to the very basics of weather and its effect on aircraft operations. This of course is supplemented by practical weather training each time a student pilot goes to fly, either on a local mission or on a cross country with his exposure to the local base weather detachment. As for follow on formal training, the only formal training that really exists is the annual instrument refresher course. Only a small portion is devoted to weather updates for our pilots. Informal follow-on training consists of either flight safety or other special meetings that may incorporate weather topics as a part of the agenda.

And of course, there is the school of hard knocks of actually flying in a variety of weather conditions. We all have become very concerned about the limited amount of formal weather training that takes place for pilots today and we are examining various aspects of the training program to see what could be done to improve it. In undergraduate pilot training, we hope to reorient some of the formal training. Right now, it's in the early part of the curriculum, very often before the pilots go to the flight line, and we're working to see if we can't move that to a more appropriate part of the curriculum. Also, we're pushing the training organization to

incorporate more weather scenarios in some of their simulator training time so the pilot will experience some of the weather problems at least in the simulator. Where our primary emphasis is going to be in the follow-on period after a pilot graduates from pilot training. We're looking at our combat crew training squadrons where a pilot gets his first exposure to the weapons system he's going to fly for a number of years to see if there are some sections of the curriculum where we may be able to inject weather scenarios and to increase awareness of the weather problems that the individual may encounter as he operates his weapon system. We're also looking at the instrument refresher course to see if there's something that could be done to better standardize training and ensure that the things that need to be reinforced on a year to year basis, are being reinforced. And we're looking for opportunities for interesting vignettes and weather packages that could be distributed around the Air Force to our weather officers for their use as they attend various flying safety meetings and special seminars with the aviators at their bases.

Since this seminar is addressing the basic needs in the aircrew weather training business, I feel I must at least express my opinion in this regard. A pilot needs to know what is the interaction between his vehicle and the atmosphere. Whether it be an icing situation, turbulence, thunderstorm or low ceiling/visibility, he needs to know what is happening to his vehicle or what can happen to his vehicle and what can happen to him in these various conditions. He needs to know what the major weather problems are that he can encounter as he operates his weapon system. Particularly he needs to know what the flight hazards are and how to avoid them. And in that regard, probably the most basic of all needs is to learn respect for the weather and what it can or cannot do to him.

In the military, we have some special needs because of the types of aircraft we operate and where we fly them. They're becoming more

sophisticated and this complicates the weather problem. Composite structures have unique problems with regard to lightning strikes, electro-optical systems and sensors are highly weather sensitive, and in many cases, are counter to the all-weather nature we attach to our Air Force. There are also a number of air traffic control improvements on the horizon with the National Airspace System Plan and the Advanced Automation Systems. These will stretch our aircrew weather limitations to the extreme. What this will mean is there will be more aircraft in the air at any one time and more aircraft trying to operate in very tight airspace thus causing the air traffic control system to push aircraft to the very edge of the hazardous envelope. This will require our aircrews to be even more aware of what's going on around them and what the weather can do to them because in many cases, the air traffic control system will not be able to provide separation from the weather. It will only provide separation from other aircraft.

So in summary, I've tried to cover a little bit of background on where we've been in the aircrew weather training business, where we are today and where we plan to go for tomorrow. I've also covered a little bit about the basic and special needs of the military aircrew member. I still think the major challenge and the bottom line to the aircrew weather training problem is that we need to find a way to instill respect for weather and its possible effects in our aircrews.

THE PROFESSIONAL PILOT AND METEOROLOGY

A VOID IN UNDERSTANDING

Robert J. Massey
Chairman, Aviation Weather Committee
Air Line Pilots Association

The Professional Pilot Meteorology Training Standards Conference is being held at an appropriate time in aviation history. Over the past several decades we have seen pilot meteorological knowledge proceed from acceptable to unacceptable to non-existent. This conference affords an excellent opportunity to begin the reversal of this trend.

By definition, professional pilots are those who possess commercial or higher-class licenses and are compensated for transporting passengers and/or freight. Those who most obviously meet the requirements are airline pilots but there are many others to whom the definition is applicable. Corporate, Air Taxi, charter, and other pilots are also professionals who, in many instances, exhibit the same lack of knowledge. My comments today address the problem specifically within the airline industry but, unfortunately, there are parallels in the other professional pilot sectors.

The simple fact is that today's pilots are, for various reasons, not knowledgeable about the fundamentals of aviation meteorology. Economics, technology, and changing pilot demographics have all assisted in creating this void. Solutions can only come from an understanding of the processes responsible for the present situation.

Traditionally, the professional civilian pilot commenced flying in the military. The airlines have demonstrated a preference for military pilots who have experience in similar types of equipment and undergone standardized training including many academic hours in meteorology. Because of this, the airlines could make some basic assumptions about the qualifications of the majority of their new-hire pilots, and tailor initial new-hire training programs accordingly. In many cases, training in fundamental areas, including meteorology, was eliminated. Initial training consisted of aircraft-specific and company procedural training.

The Federal Aviation Administration (FAA) seemingly endorsed this practice by allowing military pilots to exchange their pilot ratings for commercial pilots' licenses after passing written equivalency exams which tested their understanding of the differences between military and civilian procedures and

regulations. The FAA recognized the training required for obtaining military wings and made no attempt to reevaluate pilots' knowledge of basic flying concepts, such as those inherent within meteorology. Until recently, one could argue that this was a reasonable approach, since the vast majority of airline pilots had previous military experience. Those few, strictly civilian pilots hired by the airlines during this period had impressive backgrounds with many thousands of hours flying in other commercial endeavors. Competition was so intense that only the experienced civilian pilot was considered for employment.

Changes in supply and demand, however, have eroded the validity of this practice. During the past decade and continuing well into the next century, airlines have hired and will continue to hire an increasing number of low-experience pilots with strictly civilian backgrounds. Most major airlines have already reached the point at which they are recruiting minimum-qualification pilots who meet their employment requirements. Yet few airlines have devised training programs that allow for the varying levels of knowledge of their new-hire candidates. Rather, the airlines continue to follow the "prequalified" concept during the transition from predominately military to civilian hiring practices.

On the surface this may seem a valid concept. After all, the Federal Aviation Regulations (FARs) clearly delineate the topics and skills to be understood and demonstrated prior to an applicant's receipt of his or her commercial or air transport license. The problem, however, is that, although the FARs are well intentioned, in reality there is little quality control provided.

The exceptions are those formal training programs, operating under FAR Part 141, which are subject to stringent curriculum standards. Large commercial flight schools, university and college aviation programs, and the new ab-initio programs have established records of turning out well-educated pilots. These programs combined, however, will not meet the tremendous demand for pilot training anticipated in the next ten to twenty years. Pilots trained by individual flight instructors will still make up a significant number, if not a majority, of the pilots hired by the airlines--and this is the problem.

To become licensed, a pilot must pass written, oral, and practical exams. Certainly, throughout these rigorous processes, an applicant will have demonstrated his or her knowledge of aviation meteorology. Not necessarily! The written exam, which

must be passed prior to an applicant's undergoing the oral and practical, often furnishes the only assessment of his or her aviation weather knowledge. Many applicants prepare for the multiple-choice (written) exam by attending one of the many two-to-three-day "cram" courses. Although advertised as refresher courses, these weekend seminars often constitute the applicants' only academic exposure to topics such as aviation meteorology.

The material is presented in such a manner as to allow clever memorization of the correct answers as opposed to topic understanding. Answers to a smattering of questions on meteorology supposedly furnish evidence of an applicant's knowledge. But because the test is not segmented, that is, graded by separate topics, an applicant could conceivably incorrectly answer all meteorology questions and still pass the exam on the basis of his or her overall score. Thus the pilot applicant could possess a document (written test results) which indicates he or she is knowledgeable in meteorology when, in fact, that pilot may not have the vaguest understanding of the fundamentals of aviation meteorology.

Responsibility for preparing the student for the oral and practical phases of the examination is normally assumed by the flight instructor. The past several decades have seen major changes in the makeup of the flight instructor corps as well. Gone are the days of the wise old professional flight instructor who thoroughly schooled students in academics as well as flight maneuvers. This breed of instructor has fallen upon hard times and is rapidly being replaced by young, inexperienced flight instructors, only recently licensed themselves. They are using their new-found instructor's ratings to "build time" to compete in the hiring race. Their tenure as active flight instructors lasts only a few years. If they must depend upon flight instruction as a major source of income, they quickly realize that time spent in the air instructing in flight maneuvers pays much better than time on the ground covering topics such as aviation meteorology. In many instances, they are ill-prepared to teach the fundamentals of meteorology. Their evaluation process puts the emphasis on their ability to demonstrate and critique flight maneuvers, not on their ability to convey their knowledge of academic topics. When it comes to aviation weather, most will refer their students to a textbook or recommend the "cram" course they themselves took.

We can see the emergence of the vicious circle as we proceed from generation to generation of student to instructor, with meteorology and other topics becoming extinct. The flight

examiner, responsible for administering the oral and practical exam, is caught up in the same cycle. Upon receipt of the written test results, he or she is satisfied that the student has adequate knowledge of aviation weather and evaluates the student on aircraft procedural knowledge and flight maneuvers. Having satisfactorily demonstrated knowledge of this information and skills, the applicant is rewarded with a commercial or air transport pilot's license and seeks employment as a professional pilot.

This is a bleak scenario, but there certainly are exceptions. There are many fine flight instructors who take their responsibilities seriously, but, for the most part, they are the exceptions. Informal surveys have indicated that far too many newly licensed pilots do not have even a basic understanding of aviation weather. Some in the industry believe that impressive advances in aircraft performance, weather forecasting, and detection might compensate for a pilot's lack of meteorological understanding. This, however, is a rather naive view. In many critical flight regimes, regardless of technological advances, the pilot will continue to be called upon to equate real time situations with life-threatening consequences. There will be no time for consultation. The best-performing aircraft have yet to best Mother Nature in a power struggle; rather it always comes down to the pilot's making a decision based upon his or her understanding of the situation. We cannot afford to have a cockpit crew ignorant of aviation meteorology.

Earlier I stated that the timing of this conference was fortuitous. We have entered a critical phase of the scenario I just described. Over the next several years the last of the highly qualified, senior pilots will retire. As this happens, a process that once required an apprenticeship of ten to twenty years will now routinely take place in three to five years. Relatively inexperienced captains will command inexperienced crews. This in itself will prove insignificant IF flight crews receive the education their qualification calls for. The first step in this process is to undertake the action proposed for this conference. Before we can educate the pilot, we must determine the minimum level of understanding to be attained. No one advocates pilots becoming meteorologists any more than he or she wants them to remain ignorant. The participants in this conference represent all facets of aviation; an industrywide standard should be within our grasp.

A successful conference does not signify completion of the task. These standards must be implemented so that every pilot,

regardless of chosen training path, receives this standard of education. This will not be an easy assignment, as there are many parochial interests to contend with. The bottom line, however, is that each pilot occupying a seat in a commercial aircraft must have meteorological knowledge. We, the participants in this conference, have the opportunity to start the process. As a group we can effect the changes in philosophy, regulations, and procedures necessary to accomplish this goal.

AVIATION WEATHER TRAINING
PROFESSOR FRANK E. WENCZL
EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

The present aviation weather training evolved from the crash programs initiated in the early part of WWII. This curriculum was designed to give aircrews basic knowledge to survive in wartime conditions where casualties were expected. The training was generic - training a combat crew member. Since this course of instruction was strictly a cause-effect approach and slightly, if any, understanding or scientific analysis was acquired, the term "aviation weather" has been aptly applied. Because of this superficial treatment, the evaluation for certification was also superficial. As aviation diversified and these pilots became flight instructors, a negative trend was started. Lacking knowledge and confidence in himself and in the fledgling weather service, the instructors routinely downgraded the importance of meteorology and slighted the teaching of it. This is now quite firmly entrenched in the system. The military aviator, with his personalized weather service, became dependent on the knowledge of his briefing forecaster, whereas the civilian sector today continues the old philosophy. A look at the statistics of aviation accidents reveals an alarmingly salient fact - approximately 35-40 percent are weather related and this percentage has stayed nearly constant.

To get a feeling for the effectiveness of our present method of instruction, one has only to look at a few of the many weather-related accidents. A prime example is the Air Wisconsin accident of 1980. A pirep relayed to the crew reported "moderate rain at 23,000 feet." Apparently the crew failed to realize that to have that occur, requires very strong vertical motion upward and now it is downward - indicating abnormal conditions. Another example was the change in the direction of movement of the thunderstorm cells. In nature, as we all know, things tend to move in

another direction when a stronger, more violent, force enters the environment and should alert a well-informed crew that conditions are not ordinary. In the Southern Airways accident, inadequate interpretation of inflight radar data of severe storms was a major contributing factor. Longtime study of weather-related accidents reveals a nearly constant trend - clues of abnormal or violent atmospheric conditions show up to the aircrews well in advance of the mishap, but do not seem to make a significant impact in the decision-making process.

It is certainly obvious, that since 1941 there have been significant improvements in aircraft structure, crew training, the Air Traffic Control system, and observing and forecasting of weather. Why has the percentage of weather-related accidents not declined? The only remaining factor is the weather training, and therefore, the weather related decision-making process. Since aircraft fly for a purpose, whether it be flying cargo around the world, transporting massive number of passengers, or a military aircraft hitting a target, it is demanding for these missions to be accomplished with the utmost of success. Public opinion, and therefore, regulation, is becoming obviously clear that aviation professionals must take the lead in reducing this accident rate. Our training must prepare the crew members to sense when conditions are not ordinary - not routine - and cause them to look for more data and "analyze" the state of the atmosphere to arrive at the best possible decision. The university flight programs are the logical place to start this effort, especially since the FAA Airway Science Grants have given many schools the tools to offer a more scientific approach to the aviation meteorology curriculum.

The following recommendations are submitted to this Conference for consideration:

- 1) Increase the scientific approach to aviation meteorology training.
- 2) De-emphasize the idea that codes and reports are all a pilot needs

to know and concentrate on interpretation of the data.

- 3) Petition the FAA to establish a separate meteorology examination requirement in the certification process.
- 4) Advocate the removal of vague language in the private pilot requirements and replace them with substantive requirements.
- 5) Suggest that professional meteorologist teach as much as possible in all programs.
- 6) Attack the flight instructor weather syndrome with a heavy concentration on the meteorology training provided in the Flight Instructor Refresher Clinics.
- 7) Enlist the AOPA Safety Council to inject a new meteorological philosophy into its safety program.
- 8) Establish an on-going committee from this group to monitor aircraft accident statistics and act as an advisory group to aviation meteorology training, evaluation, and certification.

COLLEGIATE WEATHER EDUCATION FOR PILOTS

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1. INTRODUCTION

Most general aviation pilots receive weather training as part of their ground schooling from certified flight instructors who instruct independently or through a flight school. This type of weather training is usually minimal preparation and is too often directed toward teaching the student only enough about weather to pass the Federal Aviation Administration (FAA) written examination. Since only thirteen percent of the questions on the private pilots examination concern weather, it is conceivable that a student could fail the weather questions entirely and still score eighty-seven percent. Yet the most difficult decisions students will make as pilots concern weather, i.e., decisions which involve keeping themselves out of weather that they or the airplane are not equipped to handle. The statistics on this. At colleges with meteorology faculty who have an interest in aviation and with facilities for receiving weather observations, forecasts and charts, there exists an opportunity to provide an education for pilots to whatever extent they wish to pursue. Such a program is described which ranges from a minimum of two courses of five semester hours to a minor in meteorology which requires twenty semester hours of aviation-related meteorology courses.

Meteorology faculty who have an interest in aviation are a vital element in effective aviation weather education. With perhaps few exceptions, colleges require their meteorology faculty to have at least the M.S. degree with most colleges requiring the faculty with these academic credentials to teach aviation related courses. Indeed, meteorology faculty have the ability to elucidate the intricacies of meteorological phenomena far beyond the level found in the aviation weather books prepared by the FAA and the National Weather Service (NWS) for the training of pilots. (Snyder and Zimmerman, 1975, 1979).

Unfortunately, this academic preparation and resultant meteorological expertise may detract rather than contribute to effective weather education for pilots because faculty would prefer to elucidate on some more advanced topic, e.g., the numerical solution of the hydrodynamics equations. However, faculty who have an interest in aviation due to a hobby or avocation will have the motivation to teach also at the level best suited for a pilot. They will also be aware of a pilot's weather-related problems and can address these problems specifically in the syllabus.

The extent of faculty awareness doubtless is related to their level of aviation experience; e.g., aviation forecaster, private pilot, commercial pilot, etc. Although desirable, it is not necessary for faculty to hold a rating to understand the weather problems associated with the rating. For example, faculty who are private pilots but not instrument rated, if interested, can learn through reading enough about instrument flight requirements (IFR) to develop a meaningful syllabus.

Due somewhat to its location in Denver, which is a center of

meteorological and aviation activity, Metropolitan State College has meteorology faculty who are interested in aviation. Of the three regular faculty, one is a Certified Instrument Flight Instructor (CFII) and another is a Private Pilot. In addition, three part-time faculty are also utilized to teach the aviation-related courses. Of these, one is a CFII and has the Airline Transport Pilot (ATP) rating; one is an ATP; and the other holds Private Pilot and Ground Instructor ratings.

Certainly, the facilities needed for weather education of pilots must approximate those of a Flight Service Station (FSS) since most pilots receive their weather information from FSS and should be educated in the use of this information. As a minimum, facsimile equipment for receiving the NAFAX circuit and teletype or computer terminal equipment for receiving surface observations (SA) and terminal forecasts (FT) are needed. Most colleges with meteorology programs would have this equipment. Universities with research programs might also have meteorological satellite receivers and weather radar. These facilities would serve to further enhance the education of pilots.

A two-semester-hour course, MTR 141-2, "Aerospace Meteorology", is offered to meet the needs for educating students for the private pilots certificate. The syllabus follows very closely the subjects contained in Snyder and Zimmerman (1975, 1979) since a minimal objective of the course is to prepare students for the private pilots written examination. The overall objectives, however, are twofold: 1) to develop an elementary understanding of the weather and an acute awareness of the important and often crucial relationship between weather and flight, and 2) to understand the national weather system and the weather services and information available to the pilot. If these objectives are achieved the pilot should be able to use the weather services to conduct flight safely according to visual flight rules (VFR).

2. INSTRUMENT/COMMERCIAL PILOTS

A three-semester-hour course, MTR 346-3, "Meteorology and Flight Operations" is offered to meet the needs for educating pilots for the instrument and commercial ratings. MTR 141-2 or equivalent training is the prerequisite for this course. Equivalency is permitted so that pilots who received training elsewhere may take the course. They are advised that it is desirable to take MTR 141-2 when the equivalency of training received elsewhere may be questionable.

The emphasis in this course is flight conducted according to instrument flight rules (IFR), although strategies are presented for conducting VFR flight when flight in clouds may be inadvisable due to hazardous icing and turbulence. The texts required for the prerequisite course are used as reference. Some repetition of the prerequisite material is unavoidable and in fact desirable. The syllabus begins with a three-week review of Chapters 7-15 of Aviation Weather with emphasis on IFR flight. Faculty often make the subjects of icing and turbulence more graphic by discussing the meteorological situation on a recent personal flight and illustrating the weather through use of inflight photography. Since some of the students may already hold IFR ratings, they are encouraged to contribute their recent flight experiences. Recency of experience is pertinent since an effort is always made to relate the flight experience to extant weather reports, charts, prognostics, and forecasts. This technique gives the students additional practice in the

extraction of information from weather charts and forecasts and the relationship of the weather information to flight conditions.

The next four weeks are devoted to a review of Aviation Weather Services and to study of the services under development by the FAA, e.g., the VOR uplink device (Collins, 1982). The services available from private meteorological firms (e.g., Weather Services International) are also discussed. The pilot is made aware that developments in computer-related technology will soon have pilots obtaining weather information by talking with a computer (The Voice Response System of FSS Automation and Pilot Self Briefing) or by punching the keyboard of a computer terminal at the local airport. Indeed, with home computers becoming increasingly less expensive and therefore more numerous, one can envision the day when pilots will be able to obtain weather information via telephone modems on their home computers. Although pilots may still be able to talk to a FSS briefer, after a considerable wait perhaps, the trend seems to be towards more self briefings. These developments will require pilots to be even more, not less, proficient in the use of weather information.

The foregoing leads to the last eight weeks of the course which consists of flight planning exercises in every class period. Although past weather situations are sometimes used to demonstrate specific flight planning problems, the flight planning process is duplicated as closely as possible by the use of current observations, charts, and forecasts. This practice of utilizing timely weather situations makes the class more relevant and interesting to the students and the faculty. The latter is important because it keeps faculty enthusiasm from diminishing due to the repetition of the same weather situations. Also, the students know that the teacher is studying the weather situation and flight planning problem during class with them.

Usually the teacher examines the weather charts to be used in class at least thirty minutes before class and, based on the weather, selects routes anywhere in the U.S. that present challenging flight planning situations. At the outset the class is informed of the departure and destination airports, the minimum enroute altitude (MEA), the estimated time enroute (ETE) and the planned departure time. Enroute low altitude and sectional charts are available, if needed, as well as approach plates; however, the students are provided with this information by the teacher so that class time is primarily used for examining the weather situation. The students are then shown the pertinent surface chart, weather depiction, radar summary, forecast winds aloft, 12 and 24 hour significant weather prognostics and terminal weather forecasts. The teacher may also fabricate information for the situation, e.g., pireps, sigmets, etc.

The students extract and organize the weather information so that they can make flight planning decisions. The use of vertical cross section is taught so that students can organize information along the route in a vertical depiction. A student is then selected to present to the class the existing and forecast weather along the route and the student's flight planning decisions, i.e., whether the flight can be safely flown, departure time, altitudes, and alternate airport requirements. The class critiques the student's presentation and flight planning decisions. In order to emphasize that flight planning continues during the flight, the teacher poses situations that might arise as the flight is being conducted that are weather dependent. The student is presented with unforecast weather and/or in-flight emergencies (radio or engine failure), and the

student responds with alternatives to the flight plan. Apart from actually conducting the flight, the flight planning is simulated as much as possible including a post-flight analysis utilizing reports along the route at the time of the flight. Hence, a class held after 2000Z could use the 1500Z to 1600Z set of charts and reports with a departure time of 1800Z and could verify conditions for a three-hour flight using the reports and charts received after 1900Z.

A large variable in flight planning is the type of aircraft and equipment being flown. To remove this variable the class plans flights for a minimum capability IFR aircraft; a single-engine, 160-horse-power Cessna Skyhawk. This aircraft is chosen because most pilots have experience in this type of aircraft and it is the most difficult to flight plan because of its low capability. The class becomes acutely aware of the many weather situations in which flight could be safely conducted with larger aircraft which are equipped with deicing equipment and radar but not safely with the class airplane. The intent is to educate the students so that they will avoid weather situations hazardous to low capability aircraft so that they might survive to gain the experience and proficiency to fly higher performance aircraft.

3. FURTHER EDUCATION

In the process of completing the two courses described above some pilots decide that it is to their advantage to learn even more about meteorology and take additional courses. Some choose to take the curriculum leading to a minor in meteorology which is given in Table 1.

Table 1. Curriculum for a minor field of study in meteorology.

Course	Credit	Title
MTR 140	3	Introduction to Meteorology
MTR 242	3	The Use of Satellites and Radar in Meteorology
MTR 340	3	Synoptic Meteorology
MTR 341	4	Synoptic Meteorology Laboratory
MTR 444	3	Climatology
	4	Approved elective courses
TOTAL	20	

The minor field of study consists of courses from the meteorology curriculum that do not require the study of eight semester hours of calculus and ten semester hours of physics that are required prerequisites for the third and fourth year courses in thermodynamics and statics, kinematics and dynamics, physical processes, and related subjects. By structuring the minor thusly, the student can pursue further meteorology studies after study of mathematics at the precalculus level, which is already a requirement for many college majors. Often the pilot can satisfy the four hours of elective credit required for the minor with precalculus mathematics courses.

Pilots who have taken precalculus mathematics often take four hours of MTR 421, Forecasting Laboratory, to satisfy the elective credit. In this course, they prepare daily weather forecasts and in doing so develop an

acute appreciation for the task that aviation forecasters perform daily on their behalf. In MTR 140, their knowledge of meteorology is broadened by the study of meteorological history, optics, radiation, air pollution and biometeorology. MTR 242 increases their understanding of satellite and radar information, its acquisition, use, and limitations. MTR 340 and 341 gives them some scientific basis for making judgements about the accuracy of the weather forecasts they use. MTR 344 teaches them much about the variation in flying conditions over the globe and the physical basis for climatic variation.

Finally, there are those rare instances when pilots become so enamored with meteorology that they complete studies for the B.S. degree and become meteorologists who can explore the atmosphere through flight.

Acknowledgments. MTR 141-2 and MTR 346-3 were developed at the request of the Aerospace Department as required courses in the curriculum for their professional pilot majors. Gratitude is extended to aerospace faculty who encourage their students to study meteorology further by recommending meteorology as a minor field of study. I especially thank Professors Robert M. Bugg and Charlotte S. Klyn for their cooperation and assistance. I also thank the aerospace students for their suggestions for improving the courses; part-time meteorology faculty Ellis Burton, Richard Drummond, and Keith Griffith for teaching with enthusiasm; Dean Bestervelt for his support; and Ms. Christy Mourning for deciphering and typing the manuscript.

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The Current State of Meteorological Education
for
Aviation Professionals
and
Methodologies for Enhanced Learning.

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1. Introduction

The availability of accurate and timely weather data, and the ability of flight crews to assimilate and interpret that information in the context of their current "mission", have long been recognized as factors crucial for flight safety. Weather events are often cited as causative factors in aviation accidents; e.g., 27.1% of all accidents and 40.5% of fatal accidents during the period 1980-84 were weather-related (Horne, 1988). Thus, it is imperative that pilots, controllers, and other aviation professionals receive in-depth instruction in fundamental and advanced meteorological concepts, and in the acquisition and interpretation of weather data products, during their initial and recurrent training.

2. Current Weaknesses in Meteorological Education

Typically, weather education for pilots has been included as a subset of the material covered in a "ground school", the primary (or sole) function of which is to enable the student to pass an associated FAA airman written examination. The emphasis has been on memorization of concepts and the answers to published FAA questions, rather than the practical application of weather knowledge to realistic scenarios and case studies (and, ultimately, to effective preflight and inflight decision-making when meteorological hazards are present). Much of the printed material available for pilots is oversimplified, uninteresting, and out-dated. Classroom experiences tend to be based on lecture-formats, which many students find dull and boring. As a result, students may expend considerable effort getting through the material as quickly as possible, so that they can move on to other subjects which they perceive to be more interesting and more directly related to their flying activities.

Although meteorology as a science is dynamic and exciting, and new knowledge is being published in a wide array of technical publications, it takes an inordinate amount of time for this information to reach much of the aviation community. There needs to be a concerted effort on the part of aviation educators to keep abreast of new developments in the science and to "popularize" the information as they incorporate it in their courses.

A final weakness concerns the qualifications of persons typically assigned to teach meteorology, both in ground courses and for flight instruction. In the case of classroom courses, teachers may either be highly-trained meteorologists with little or no background or experience in aviation and poor understanding of the needs of flight crews, or experienced aviators with little formal meteorological training. As a result, it is sometimes difficult for students either to see the practical application of the material being discussed or to have it presented at a sufficient depth of understanding.

In the case of flight instruction, the economic realities of being a flight instructor often dictate that young, relatively inexperienced pilots, who themselves may have poor knowledge of aviation weather concepts, are teaching beginning student pilots. The situation tends to perpetuate itself, because the latter students soon become certified flight instructors and begin to teach entry-level pilots, as they accrue enough flight experience to move "up" to a better-paying job as an airline or corporate pilot.

As a result of the weaknesses cited above, many active pilots do not have the theoretical and practical knowledge required to operate safely, particularly in instrument meteorological conditions (IMC) when thunderstorms, icing, turbulence, and/or low ceiling/visibility are present. Unless these individuals are airline or corporate copilots, who can learn under the tutelage of an experienced captain to safely cope with weather and to make appropriate

preflight or inflight decisions, their decision-making ability may have to develop through a series of often frightening experiences, hopefully before they are involved in an accident or incident. Clearly, the need exists to help young pilots develop practical knowledge of aviation meteorology and the ability to make consistently safe and appropriate operational weather decisions.

3. Methodologies for Enhanced Aviation Weather Education

It is proposed herein that there are at least three primary areas of operational weather expertise required of pilots. They are:

- 1) The ability to obtain, evaluate, and interpret appropriate weather data products;
- 2) The ability to make consistently safe in-flight weather decisions, using both their own observation of the atmospheric events unfolding around their aircraft and weather information from Flight Service Stations and Air Traffic Control facilities;
- 3) The ability to exercise good judgement with respect to the initiation, continuation, or termination of a flight. This includes the capacity for developing a number of alternative courses of action, prior to takeoff.

Obviously, the ability to make an informed decision regarding the safe operation of a flight depends to a large degree on the pilot's skill in obtaining timely and accurate weather data products, along with the capacity to interpret and assimilate the data into his/her knowledge of the overall requirements for the flight. In addition to the weather data, he/she must take into consideration a number of other factors, including the equipment installed

in the aircraft, its performance and range capabilities, pilot experience and currency, and geographical (terrain) effects.

The ability to obtain, read, and interpret weather data products, from both government and proprietary sources, is a skill which must be developed and maintained through practice. Students must have access to printed copies of teletype and facsimile data, so that they can practice reading and interpreting them in an unhurried and non-pressured environment. One unfortunate result of the FAA Flight Service Station Automation Program, is that it is highly unlikely that most pilots (students included) will have routine access to hard-copy weather data. This makes it very difficult and frustrating for inexperienced pilots, who must try to record and understand the information given by a briefer over the telephone.

In response to the need for students to have available facsimile and teletype meteorological data products, the Department of Aviation Technology at Purdue University has developed The Airway Science Meteorology Laboratory. This facility, made possible by a grant from the FAA as a part of its Airway Science Grant Program, is described in detail in Carney and Beering (1989).

Briefly, the Airway Science Meteorology Laboratory is composed of a four-room complex, with additional microcomputers in two other buildings, networked to two minicomputers in the laboratory. The main laboratory area contains a pilot self-briefing room, a microcomputer-based teaching laboratory, and administration and electronic data-acquisition areas. Data available include FAA 604 circuit alphanumeric data, DIFAX facsimile products, and Kavouras dial-up radar and satellite imagery. Two rack-mounted digital airborne radar sets (both x-band, with color and monochrome displays) and a 3M Stormscope lightning detection unit complete the laboratory hardware.

Of the eleven microcomputers currently networked to the minicomputers in

the laboratory, 1 is located in the students' flight-planning area for their exclusive use, 3 are located in faculty offices for faculty/student use and system development, and 1 is maintained in a classroom for in-class weather briefings. The latter installation is equipped with a unit which allows projection of the weather data, using a common overhead projector. Students can also be assigned to the laboratory for special instruction in the use of its equipment and products.

Planned projects for the Meteorology Laboratory include image-processing software and the inclusion of facsimile products as files in the database; intelligent weather briefings, constructed around a great-circle flight planning program already in operation and menu-driven user requests; and the development of other weather products, such as on-line calculation of stability indexes for a requested upper-air station, plotted thermodynamic charts, and computation of the likelihood of icing at selected altitudes. Additional efforts are planned to develop video-taped case studies of severe weather events, using the radar and Stormscope imagery in the laboratory.

All of the efforts described above are motivated by the need to provide student pilots, and future air traffic controllers and aviation managers with opportunities to study weather data in essentially real-time, so that they can learn in the safety of a laboratory or under the guidance of a professional educator while in flight, to evaluate the weather and make appropriate decisions concerning flight safety.

Professional pilot students in either the Airline Pilot option or the Corporate Pilot option are given further opportunities to learn preflight and inflight weather decision-making and avoidance by participating in the Supervised Flight Operations (SFO) courses. These courses allow the students to serve as copilots on the University's two turboprop Beechcraft King Air

aircraft and to fly as observers in the University's turbojet Mitsubishi Diamond IA. Starting in August, 4 students per year will also participate as copilots on the Diamond, in a year-long internship and Honors Program. The SFO program allows students to learn weather decision-making in a live, corporate-aviation laboratory, under the supervision and guidance of four "professor-pilots". This is analogous to the experience cited above for airline and corporate copilots, but it occurs much earlier in the student's career, and is conducted by professional educators whose primary purpose (in addition to the safety and comfort of the passengers) is to teach the students to operate safely in all types of weather, in some of the busiest airspace in the world (including Chicago, Washington, and New York).

In addition to the exposure received in SFO and earlier in their flight training, students in the Airline Pilot option who are assigned to the DC-8 and B727 simulators owned and operated by the University are frequently asked by their instructors to access the weather database for a preflight briefing prior to their simulator sessions. The weather data can then be used by the instructor to discuss potential hazards and courses of action to be utilized by the "airline" crew in conducting the day's simulated flight.

4. Conclusion

It is clear that pilots and other aviation professionals must be proficient in incorporating weather concepts and current data in their decisions relating to flight safety. The challenge for educators who deal with these individuals during their collegiate education is to help them develop judgement and interpretation skills in a safe and structured environment and to incorporate the most current knowledge in a timely and interesting manner. The current paper has described some of the facilities and methods used by faculty

of the Department of Aviation Technology at Purdue University to provide for this critical part of our students' aviation education.

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A WEATHER CRISIS

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In the United States, weather has been identified as the cause or primary factor in over 40% of all fatal aviation accidents in the past 5 years. This accident rate could be improved if accurate and timely weather information were more accessible to pilots for making both pre-flight and in-flight decisions; and if more pilots understood basic principles of meteorology.

The lack of timely weather information available to the flight crew has reached a critical level. Advances in the collection and assimilation of weather observations, forecasts and other data are being made on a continuing basis. However, a pilot's ability to access this information proceeds to decrease. Current dissemination procedures are antiquated, inadequate, or completely unacceptable. Furthermore, the information is often received in an ambiguous format which requires decoding and further interpretation by the flight crew in order to make it both comprehensible and useful. In a time critical situation, this often means the information provided cannot be used.

A critical problem exists concerning meteorological data--"Information Constipation." What is meant by that? The data is there, but the pipeline is clogged. The average person sitting

at home has better access to hazardous weather information than a pilot. For pilots, this problem materializes in 3 forms:

1 - The FAA or NWS has the information and the pilot can't get to it.

2 - The information has been transferred to the FAA facility but it is not relayed to the flight crew.

3 - When the pilot receives the information he can't use it.

Severe weather is a contributing factor in many fatal aircraft accidents. Windshear near the ground is one of the leading killers. In some of the most recent windshear accidents, "someone" had critical information that may have prevented the accident and 1) had no mechanism available with which to alert the flight crew or 2) conveyed the information but it was not relayed to the flight crew. Why? It is simply not a priority. The Office of Technology Assessment observed: "...current air/ground communications are not adequate in some cases to support pilot needs for both real-time ATC and real-time weather information. Providing ATC information to ensure separation between aircraft in the air and alert aircraft flying too low to the ground is the controllers' first priority. At times controllers are too busy to transmit weather information to pilots or are distracted from transmitting information by more

urgent demands to separate traffic. Pilots need better weather information in the cockpit, and programs to develop message formats and workable air/ground communications for weather information are important immediate safety needs."

One of the informational problems that occurs almost on a daily basis during summer months is the ATC transfer of SIGMET information. A SIGMET is issued when severe icing; severe or extreme turbulence; duststorms, sandstorms or volcanic ash lower the visibility to less than three miles occur. A Convective SIGMET is issued when tornadoes; lines of thunderstorms; embedded thunderstorms or hail greater than or equal to 3/4 inch occur. This is an important weather advisory about weather that is hazardous to any aircraft. Once forwarded to Air Traffic Control (ATC), the SIGMET is read on a time-permitting basis. Most often, the state references at the beginning of the SIGMET are omitted from the reading to save time. Consequently, pilots receive the identifying boundary in terms of 3-letter identifiers of radio navigation aids. To further compound the difficulty in determining the location of the SIGMET's applicability is a recent FAA procedure which will not allow a VOR (radio navigation station) to have the name of the nearest airport unless the station is located on the airport. In cases where these stations are located off-airport (as most of them are), the pilot loses a quick geographical reference. It may take 5-10 minutes for a flight crew to determine the area a SIGMET is warning them about by decoding the 3-letter station identifiers. During a critical

phase of flight or any operation below 10,000 feet, the crew does not have this amount of time available to spend on SIGMET orientation and it therefore often goes by totally disregarded. A prime example of this problem is the Northwest Orient DC-9 crash in Detroit two summers ago. According to the cockpit voice recorder, the Captain spent one-third of his last thirty minutes of life trying to figure out and decode SIGMETS that were given to him during the taxi out to the runway.

In the General Aviation sector, it is not severe or unusual weather that is the killer. It is most often a pilot's continuance of a VFR flight into marginal VFR and IFR conditions caused by fog, haze or rain. These conditions are often predictable by a pilot himself--providing the pilot has some basic understanding of weather. Basic understanding of weather is not a high priority. The FAA maintains high priority on weather codes, reports and symbols instead of meteorological theory. Although this is where the emphasis is placed, most licensed pilots don't even recognize the symbols on a weather chart much less understand the information they are trying to convey. Many students can recite required information for the written exam, but they can't apply it in the real world of pre-flight weather briefings. Pilots need an understanding of weather that is far broader in depth. This leads to a second critical problem.

A second critical problem exists concerning pilot knowledge of meteorological data. When and if information is obtained, many pilots don't know how to apply it. They simply do not have the background training to know what to do with the information that they are able to obtain. Why is this so critical in the General Aviation sector? It is critical because of the advancement in technologies along with reductions in government staffing which are forcing the pilots toward a "self-briefing operation." This problem will only grow in the coming years as the aviation industry continues to technologically advance itself.

To begin an effort to correct this problem, the focus of what the pilot must know needs to be narrowed. There must be an effective balance between theoretical academics and "real world" application.

What is it that pilots should operationally be concerned about? At a minimum, it should be thunderstorms (and associated wind shear), structural icing; respect for these phenomenon and the effects they have on aircraft; and radar utilization. Yet, how can a pilot have respect for the weather absent background knowledge and data of the physical processes that go on within these 3 basic elements? How can the effects be understood without first knowing the physical processes that go on within the atmosphere itself? A more important question is how will the necessary, minimum training be accomplished--and why isn't it

being addressed currently?

Why doesn't the General Aviation pilot know more about weather? The prevailing factor is deficiencies in weather training. There are a number of reasons for this: there are few training materials available to pilots; of materials available, most are very technical and "dry;" there is no regulatory requirement to know meteorology well; and because of these factors, instructors and flight examiners don't understand weather either.

There are three major checkpoints for knowledge along the path a student pilot travels in attempting to obtain a pilot rating--the written exam; the flight instructor and the flight examiner.

A pilot can get past the first checkpoint because the written exam only deals with a superficial knowledge of weather--most of which is weather codes, reports and symbols. In fact, it is possible for a student to miss every weather question and still pass the written exam.

The predominant problem with the flight instructor is that he knows little about weather himself. Therefore, the instructor is reluctant to spend any more time than is required to get the student by the written examination so as to not embarrass himself. Instructors would much rather spend the majority of

pre-flight/post-flight time with things they know a lot about such as aerodynamics, stalls, navigation and communication technique etc. Consequently, good weather knowledge does not get passed along to the student pilot.

The last check point between a student pilot and his license is the designated flight examiner. Most designated examiners are former flight instructors. So, not many examiners have a vast knowledge of weather (most have very little) and therefore will not spend a lot of time on the oral portion of the flight test discussing weather related topics and issues.

One area that separated the professional pilot community from the nonprofessional pilot was the nonprofessional's ability to continue to fly without any type of required refresher after a license or certificate was issued. A change in this philosophy occurred when the FAA amended its requirements for a biennial flight review for licensed pilots. This was a major step toward proficiency maintenance and safety of flight. Unfortunately, there were no specific guidelines as to what must be covered. More precisely, there was no mention of weather information or knowledge. Thus, a licensed pilot can still slip by a now required refresher without adding to or be questioned about his education of meteorology. The review is conducted by a certificated flight instructor. As mentioned earlier, most instructors don't understand weather either, so they certainly aren't going to delve into it on a biennial flight review.

Clearly, a change is needed in regards to the weather training a General Aviation pilot now receives (more accurately, does not receive). Various avenues are available from Federal regulation of required weather courses/schools to segmented testing; more in-depth coverage of weather during the written exams, the oral exams and the biennial flight reviews. Any one of these avenues would be effective in increasing pilot knowledge of meteorology (if only one of them would be implemented...).

CROSSCHECKS, BACKDOORS, AND OUTS:
PRACTICAL WEATHER TIPS FROM THE PRO'S
C. Elaine McCoy

Abstract

Professional pilot education must address the coherence of weather education in pilot training. Lowtime VFR and IFR pilots face a precarious leap from little or no actual weather experience during their training to the role of PIC with all the associated responsibilities. Weather education varies radically and many are uncertain about what weather information they should obtain. This presentation summarizes a recently conducted survey of professional pilots. The purpose of the survey was to identify the techniques that work for high-time professionals. These common key indicators or patterns could then be offered to test groups of low time pilots to determine if there is improvement in weather analysis and comprehension through the identification and use of these keys.

Background

The newly certificated Private Pilot is often admonished, "Now you have a license to learn." The same sage advice often accompanies the endorsement of the instrument rating as well. While this may be true, it is not necessarily helpful. The rights and privileges of the certificates and ratings are bestowed in full, and the novice in either category now is to assume full responsibility for himself or herself, passengers, and those (underneath) on the ground. While increased instrument training for the private pilot should improve aircraft control during the inadvertant penetration of IMC, the impact on the pilot's willingness to risk encountering such conditions as well as pilot ability to anticipate such conditions remains undetermined.

Lowtime VFR and IFR pilots in a parallel manner face difficult decisions regarding weather. A new vista awaits each requiring an analysis of weather conditions which must be meaningfully interpreted in terms of individual pilot experience and aircraft capability.

Weather education varies from minimal self-taught home study courses designed to pass written exams (in which case one might hope that thunderstorms or icing might offer airborne erstwhile pilots a multiple choice selection of familiar answers), to university courses in aviation weather, to specialized seminars offered by manufacturer's of weather detection equipment.

Nationally, public weather information service is being reduced and centralized. Interpersonal communication is being replaced by increasing reliance on the use of computerized information systems, e.g. IVRS, that respond to discrete inquiries. Fewer opportunities to walk in and review information

directly are available. To fill the gap, private companies are providing for fee data and graphic displays. Even the most dedicated student who has studied Aviation Weather and Aviation Weather Services and who has had the opportunity to visit a Flight Service Station might remain confused by the plethora of meteorological charts, reports, and forecasts available if his or her background lacked weather analysis strategies.

Exposure to information and the assimilation of that information to produce a framework for preflight and enroute decision making are not always one and the same. Lowtime pilots confess to gathering reports and information without always understanding what they have obtained in terms of their planned flight. It almost seems as if a belief in the procedure of obtaining the information is deemed sufficient protection. As a knowledge and product oriented society, critical analysis and subsequent decision making based on that analysis may remain a silent partner to the data. "Did you get the weather?" may be asked the trainee more often than "what does this mean in terms of the ceilings? visibility? your flight?" "What is it?" may result in a reiteration of winds, temperature-dewpoint, etc. Local training flights are frequently unconcerned with regional or area weather. Later, employers also want applicants to already possess weather experience. Captains are to have obtained weather experience as First Officers; Alaska pilots are supposed to have Alaska time prior to employment for hire in Alaska. So how can aviation educators help ensure the safe journey from novice to professional status?

This survey sought to identify an expert system used by professional pilots--those "old, not bold" pilots who have survived that initial period of having a "license to learn." If there is an identifiable set of keys to weather analysis utilized by the pros, these may also provide keys for weather interpretation by lowtime pilots.

The Study

Subjects. A small sample of sixteen professional pilots constituted the subject pool. These individuals collectively represent 116,900 hours of flight time, or an average of 7306 hours; 337 years of professional experience, or an average of 21 years; and include corporate, 135, test pilot, and airline experience across the country. Four are active CFI's, eight are inactive CFI's, and four have not held instructional certificates.

Questionnaire

Rationale. The "Expert Systems Weather Analysis Questionnaire" was designed as a telephone interview. The questionnaire seeks to identify: (1) the specific types of weather information the professionals desire; (2) whether weather is visualized; (3) the approach to visualization of a weather

picture; (4) the impact of the type of equipment used as a crosscheck on other responses; (5) advice for lowtime pilots; (6) what phase of their career they perceived to be the most dangerous in terms of "pushing" the weather; (7) if their attitudes changed, and why; and (8) demographic data.

Responses and Commentary

The collective top five types of weather information agreed upon by the pros include: Terminal Forecasts (12/16), Record Observations (10/16), Winds Aloft (9/16), PIREPS (7/16), and Trends (6/16). The openness of the question contributed to some items of specific nature such as visibility and pressure being listed separately although they would be available in the SA or other sources. These included moisture (1/16), stability (1/16), pressure (1/16), upper air (1/16), visibility (1/16).

Area Forecasts were requested by 5 pilots, while an additional 4 requested surface/synopsis information with 3 also desiring fronts and 2 direction of movement of systems. "Closest Good Weather" was sought by 3 pilots. These groups sought larger area coverage, but cannot be combined for a total number.

Severe weather concerns are reflected specifically in radar summaries (3/16), and Sigments and Airmets (3/16). These concerns reappeared in responses to question 2 regarding the focus during summer and winter flight. For summer months 6 desire additional information concerning thunderstorms and convective activity. Seven require no alteration of information, and two others would like ground temperature (1/16) and the stability index (1/16). Winter elicited a response of no change in 5 respondents, icing concerns (7/16), thunderstorms (1/16), runway conditions (1/16), and surface winds (1/16). Icing-related information was sought by a variety of approaches: reports (4/16), freezing level (1/16), ground temperature (1/16), winds aloft (1/16), tops (1/16).

Key criteria included trends which ranked in the top 5 items listed by the collective group. Only one pilot indicated that trends were not very important. In decreasing rank order trends sought included: Temperature-dewpoint (12/15), Ceilings (10/15), Surface Winds/shift (9/15), Pressure (7/15), Visibility (5/15), improvement or deterioration (3/15). Other trends mentioned singly were temperature, forecast comparison to currents, any, precipitation beginning and ending, radar histories, areas, SA's, and movement.

Visualization of Weather Information. A portion of the survey sought to confirm the notion that pilots visualize weather based on information received. All sixteen not surprisingly agreed that they visualize, or picture, the weather. Less interest was exhibited in departure weather and in profile weather than in destination and planview information. A good follow-up for departure would have been "to what extent do you rely on looking at what you can see from the ramp?" While that may seem a light-hearted comment, an experienced eye seems at times to almost

"see" ice in clouds.

Several corporate pilots indicated that they rely very little on the public sources of weather information. Rave reviews were given for both WSI and TABS weather information services. TABS was especially noted for graphics. These pilots are provided the graphic, visual portrayal of information that is becoming less available to the General Aviation novice.

VFR-Only SEL. An entertaining break for the discussion was provided by asking how their weather information needs might change if they had to fly VFR in a single engine aircraft. Responses ranged from those who indicated the aircraft made no difference (6/16) to chuckles and comments about Single Engine VFR flight that cannot be repeated here. "Cautious," "Violently," "Scared ---," and "Wouldn't go" preceded more practical advice. Overall the group desired more enroute weather, more information in general, Airmets, Sigmets, Convective Outlooks, more "outs" because of less range and altitude capability, and alternates, winds and icing information became more important. High altitude winds would be deleted. The pilots indicated feelings of increased vulnerability and greater concern with alternates even though VFR was stipulated. One pilot wanted less information--he wouldn't go unless the weather was practically CAVU.

Tips. Responses were given sincere thought and careful attention by the respondents.

- * Check the weather, go look at the charts, verify with a more experienced pilot.
- * Make a 180 when conditions worsen.
- * Learn the basics.
- * Use constant pressure charts and note trends.
- * Count safety buffers, outs, keep at least two options.
- * Don't exceed limits.
- * Collect information, make your own decision, check trends.
- * Know difference in IFR.
- * Keep after it until you get what you want. Be aggressive.

Don't hang up until you understand.

- * Use your head, don't get in over your head, know your limits and act appropriately.
- * Forecast on your own. Don't just accept what they say.

Be critical.

- * Never take it for granted. Keep reassessing.
- * Know where the good weather is. Have an out, a backdoor, or don't go.
- * Leave yourself an out, a backdoor. (These two responses were from completely different areas.)
- * Have a place to go--a way out--for 180. Use ATIS enroute to keep track of conditions below for emergency use.
- * Respect weather. Explain to briefers your experience level.
- * Go look. Use all available information.

Risk taking. Perceptions of the greatest risk taking in terms of flight in questionable weather indicated a fairly high amount of flight time involved compared to the "novice" pilot domain. Despite one pilot's reference to the problem being low time--1000 hours, the pilots suggested personal dangerous zones that ranged from 200 to 4000 hours. The most common reference given by 5 pilots indicated 1000 hours.

Attitude changes. Two pilots indicated that their conservatism was enduring, no change. The remainder indicated that changes had involved getting scared, wanting to live, structural damage in flight, and that getting there seems less important now. Early "learning" experiences one labeled as stupid and another similarly commented that ignorance is bliss commenting on his lack of understanding.

Discussion

An incredible amount of experience is represented in the Expert Systems pilot sample in this study, 337 years of professional pilot experience. While a wealth of understanding lies in that 337 years, problems also arise in determining its translatability to lowtime pilot requirements. Eyes that have seen innumerable fronts, minds that have crosschecked currents and forecasts day in and day out, hands that feel the slightest shudder, the first hint of turbulence, seeing unforecast weather, all lead to a degree of sensitivity and self reliance the novice must lack.

This difference, though, does not preclude the usefulness of the recommendations of these pros. Perhaps a valuable general observation is that these seasoned professionals recognize their earlier times of poor judgment in weather decision making and are willing to share that as well as their "tips" to assist others. Such cooperation provides a positive role model to the "younger" pilots coming along. All too often the novice pilot shares the FBO with a macho (also amateur) Mr. Cool who swipes the ice off of the wings and insists its not too bad out there. Understatement of the severity of weather conditions is one difficulty with a novice asking advice around a hanger in an unfamiliar airport.

The identification of the top five types of weather information provide insight and the ability to cross check. Trends includes histories of other specific types of information. The Expert Pilot pool indicated that series of SA's should be watched and compared critically to the Terminal Forecasts. Winds Aloft offer both temperatures if requested and information necessary for calculating ground speed and so fuel needs. PIREPS are a good source of current information for specific locations not always accessed by lowtime pilots. Instruction in the proper analysis and usage of PIREPS might assist the formulation of an accurate weather picture. "Trends" is valuable in that it directly points to a process of analysis, of comparison and contrast rather than to a specific set of static data.

Significant interest was also indicated in a larger view of weather coverage with admonitions to know the location of good weather is particularly useful for the newly instrument rated pilot likely to be flying single engine IFR and for long range VFR or trips laying over several days VFR.

The tips provide a reinforcement of what training and common sense should have at least partially established. Hearing the advice from the professionals may make a greater impact. The hope here is to devise a system that works for the novice in a reasonable amount of time and without supervision. There do seem to be identifiable factors and procedures that can assist prioritizing weather information access. The list of tips clearly offers the best general advice: crosschecks, backdoors and outs.

POSITION PAPER ON ARMY AVIATION METEOROLOGY TRAINING

1. The purpose of his paper is to describe to the aviation community the basic composition of aviation meteorology training conducted for the Army aviator at Fort Rucker, AL. The US Air Force is directed (IAW AFR 105-3) to provide operational weather support for the Army to include training Army personnel to use and understand weather information. The current aviation meteorology training program at Fort Rucker should have an Air Weather Service staff weather officer serving as lead proponent for course development and instruction.
2. There are 70 aviation related courses taught at Fort Rucker with approximately 4000 students trained per year. Aviation meteorology is currently taught in five of these courses:

<u>COURSE</u>	<u>WX HOURS</u>	<u>CLASSES/FY89</u>	<u>STUDENTS/FY89</u>
a. Entry Rotary Wing Course	22	24	1650
b. Captains Course	3	5	613
c. Examiners Course	5	12	98
d. W.O. Seniors Course	8	8	267
e. OV-1 Course	5	<u>15</u>	<u>37</u>
FY89 TOTAL		64	2665

In addition to these courses, Fort Rucker develops aviation meteorology course material for programmed texts and two Army correspondence courses. Fort Rucker also conducts training involving hundreds of students per year in which weather instruction or consultation could be beneficial. These courses include: Nine instructor pilot courses, a master warrant officer's course, air traffic control courses, and the fixed wing multi-engine qualification course. The current lack of resources prohibits weather instruction/consultation in most of these courses.

3. Aviation meteorology training must focus on the basics of the science, and the products and services available to the aviator. The content and instruction of any aviation meteorology course must be tailored to each class, their type of aircraft, their mission, and the most likely area of operations. A U.S. Air Force, Air Weather Service perspective is needed for the Army aviation meteorology training conducted at Fort Rucker. With advances in electro-optical weapon systems, other weather sensitive technology, and Army tactical aviation requirements, Fort Rucker provides a single location where all Army aviators can be exposed to Air Weather Service support capabilities. Air Weather Service has information, and support products which should be incorporated into Army aviation training. The civilians and Army warrant officers currently providing course instruction and review are doing a fine job, but cannot provide the same focus on aviation meteorology that would be available from a USAF Air Weather Service source.

4. Because Fort Rucker is the center for all Army aviation training, this is the best place to concentrate exposure to aviation meteorological material. By using one expert staff weather officer, Air Weather Service can act as the primary proponent in structuring course material, providing instruction and preparing the Army aviator for the services and support available at an operational unit. Proper weather instruction in the training environment pays immediate and long term dividends in orientating the aviator to the impact of weather on their aircraft and the type of weather service they can expect wherever they are assigned.

Major Pearson/Det. 9, 5th Weather Squadron Commander/AV658-3902, 205-255-3902
/mr/11 Apr 89

Career Pilot Weather Training Curriculum -
A National Weather Service Perspective

James T. Skeen, Jr.

National Weather Service
Silver Spring, Maryland

While the National Weather Service (NWS) has no national program for the training of pilots, we are vitally interested in ensuring that the nation's pilot force, including career pilots, is sufficiently trained in meteorology to make the informed decisions necessary to operate in a safe and prudent manner. To date, our support of training efforts have been focused on a local or regional basis. Meteorologists from NWS field offices and regional headquarters provide numerous presentations in support of Federal Aviation Administration (FAA) safety seminars. They also work with many local and national flying groups and organizations to present forums and seminars on aviation weather and the weather information system. A prime example of this type of cooperative effort was a well attended microburst seminar held in San Antonio, Texas, in December 1987. The audience for most of these

efforts has been the general aviation pilot community. However, some NWS-hosted seminars have had significant career pilot attendance.

From the NWS viewpoint, a standarized career pilot meteorology curriculum should strive to impart an understanding beyond that solely of atmospheric processes and their effects on aircraft performance. Additional topics that would be useful in a training curriculum would include some of the following subjects. First, particularly for civilian pilots, it is necessary that they have a basic understanding of NWS products and services and of the effect our impending restructuring will have on them. Second, it is vitally important that all pilots be familiar with the new technologies that will rapidly be in place and be able to effectively use some of the new data sources that will be available directly to the pilot. Third, a thorough understanding of the NWS in-flight advisory program is essential knowledge for the professional aircrew.

What is important for pilots to know about NWS products and services? First, it would be useful for the pilot to have an understanding of the role of the National Aviation Weather Advisory Unit (NAWAU) in the National Airspace System. The NAWAU, a component of the National Severe Storms Forecast Center in Kansas City, Missouri, is responsible for, among

other products, the issuance of Significant Meteorological (SIGMET) advisories which are broadcast by the FAA to enroute aircraft.

A second vital link between the NWS and the pilot community is the Center Weather Service Unit (CWSU) located at each Air Route Traffic Control Center (ARTCC) except Honolulu. This program of placing NWS meteorologists within the ARTCC's to provide nowcasting and advisory services to the FAA has matured into a very successful cooperative effort between the two agencies.

The basic level of aviation weather support which pilots should have knowledge of resides in the Weather Service Forecast Office (WSFO). WSFO's currently have the responsibility for issuing terminal forecasts (FT's) for more than 500 locations and over 300 route and local area aviation forecasts. WSFO's also provide severe weather warning service to selected local airports.

The NWS modernization effort phased in over the next several years will provide an improved and more frequently updated suite of aviation products. However, modernization will also shift NWS offices, in many instances, off airport property.

Along with the consolidation of FAA Flight Service Stations, this will result in fewer face-to-face encounters with meteorologists or professional weather briefers for civilian pilots. With this lack of face-to-face interaction and increased reliance on self-briefing through the use of private data services, we foresee a growing need for pilots to have a greater comprehension of encoded weather data and charts. In the future, the career pilot should have a much greater ability to interpret weather information in terms of the weather's impact on planned flights and in-flight decisions.

The emerging new technologies which are driving the NWS modernization and restructuring will also be prime candidates for a future training curriculum. Among those that have a special relevance for pilots are Next Generation Weather Radar (NEXRAD), Terminal Doppler Weather Radar, and Automated Surface Observing Systems (ASOS).

We believe professional pilots should have a basic understanding of the principles of doppler technology as well as the pertinent aviation products derived from the NEXRAD. Professional pilots will also need to become familiar with the capabilities of the FAA terminal doppler weather radar. These terminal weather radars will be installed at selected airports around the country.

One of the most obvious new technologies that professional pilots will encounter is the ASOS. More than 1000 ASOS systems will gradually be installed over the next several years replacing, for the most part, human weather observations. It is essential that the performance characteristics of ASOS be thoroughly understood by pilots.

Other new technologies such as wind profilers and automated aircraft observations and weather satellite upgrades offer significant opportunities for improved aviation forecasting. Regional lightning detection systems (LDS) have proliferated in the past few years. Also, an effort is underway to produce a national lightning strike graphic by compositing the various LDS's. In the future, professional pilots should be at least familiar with these sources of data.

Finally, a pilot training curriculum should include information concerning the NWS in-flight advisory program. Pilots should know the meaning of terminology such as SIGMET, Convective SIGMET and Center Weather Advisory.

Professional pilots have a great many needs beyond that covered above. Obviously, phenomena such as thunderstorms and its related hazards, wind shear, turbulence and icing should

be included in any curriculum. Airborne weather radar interpretation offers another fertile area where comprehensive training is desireable.

We are convinced though that since there are fundamental changes ahead in the data collection, processing and dissemination of weather information, professional pilots will need a more comprehensive background in applied meteorology than ever before. Also, developing good decision-making skills should be emphasized by integrating operational scenarios (e.g. thunderstorm development in terminal area) into the curriculum.

BIOGRAPHIES OF THE ATTENDEES

This section of the report lists the credentials of the 31 participants who participated in the conference.

Statistically, this was an impressive group of individuals to decide just what a pilot needs to know about meteorology. Of the 31 participants, 21, including 9 of the 11 civilians, were pilots with at least a private airplane rating. Twenty individuals held at least one college degree in meteorology or climatology. Eleven participants were both pilots and meteorologists. Two had a doctorate in meteorology and an airline transport pilot rating (the "Ph.D. of flying").

Thirty different organizations sent representatives. The civilians included a member of the National Weather Service Aviation Support Branch; a flight safety inspector from the Federal Aviation Administration office in Denver, Colorado; a director of the Research Applications Program of the National Center for Atmospheric Research (NCAR); the chairman of the Aviation Weather Committee of the Air Line Pilots Association (ALPA); the chairman of the aviation committee of the National Weather Association (NWA); a representative from the aviation weather committee of the American Meteorological Society (AMS); and the heads of the meteorology departments of United Airlines and Trans World Airlines. Four professors from universities

affiliated with the University Aviation Association (UAA) attended including Embry-Riddle Aeronautical University (Daytona), Ohio State University (Department of Aviation), Metropolitan State College (Earth Sciences), and the University of North Dakota (Department of Atmospheric Science). Purdue University (Department of Aviation Technology) was able to participate substantially by mail. Because of the role the military played in organizing the meeting, there were a large number of Air Force organizations represented including the Air Force Academy (Department of Economics and Geography), the 4th Weather Wing, the Air Force Instrument Flight Center (a pilot and a meteorologist), Headquarters of the Air Weather Service (Scientific Services--a pilot), the pilot trainers for the three major flying commands: Strategic, Tactical, and Military Airlift Commands, and members of their respective weather wings. The Army sent an Army flight warrant officer and the Air Force commander of the local weather detachment at their training facilities. The Navy sent an education specialist from their primary flight training wing who did an extensive study of the needs of naval aviators.

PROFESSIONAL PILOT METEOROLOGY TRAINING STANDARDS CONFERENCE

ATTENDING ORGANIZATIONS

U.S. AIR FORCE

U.S. Air Force Academy	-	Capt Tim Miner
USAF Instrument Flight Center	-	Major Ron Liddell
HQ Air Weather Service	-	Capt Jim Surey
3rd Weather Wing	-	Capt Georges Kleinbaum
Strategic Air Command	-	Col George Frederick, Jr
Air Training Command	-	Capt Ivan Friend
5th Weather Wing	-	Lt Col Bob Hey
Tactical Air Command	-	Lt Col Jack Rachels
7th Weather Wing	-	Major Terry Martin
Military Airlift Command	-	Capt Larry White
4th Weather Wing	-	Capt Bartlett Hamilton II
		Major John Voss
		Major Mark Older III
		Lt Col Ron Sergott
		Col Richard Vogt
		Capt Lynnette Franchi
U.S. Navy	-	Mr Ken Roose
U.S. Army	-	Major Douglas Person (USAF)
		WO4 Robert Buchanan
FAA	-	Mr Richard Drummond
NWS	-	Mr Jim Skeen
National Center For Atmospheric Research	-	Dr Wayne Sand (AMS)
Embry -Riddle Aeronautical University	-	Prof Frank Wencel
University of North Dakota	-	Dr Mike Poellet
Metropolitan State College	-	Dr Robert Boudreau (NWA)
Ohio State University	-	Dr Elaine McCoy
Airline Pilots Assoc	-	Mr Robert Massey
United (Meteorology)	-	Mr Carl Knable
TWA (Meteorology)	-	Mr Don Eick
Private Consultant	-	Mr Jim Johnson

PARTICIPATING ORGANIZATIONS

Purdue University	-	Dr Thomas Carney
American Meteorological Society	-	Mr Richard Wagoner

NAME: Dr Robert D. Boudreau

TITLE: Professor of Meteorology
Chairperson, Department of Earth Sciences

ORGANIZATION: Metropolitan State College

ADDRESS: Department of Earth Sciences
1006 11th St., Box 22
Denver CO 80204

PHONE: (303) 556-3166

FLYING EXPERIENCE:

MILITARY: RATING:
HOURS: INSTRUCTOR:
AIRCRAFT:

CIVILIAN: FAA RATINGS: Airline Transport Pilot, CFI, CFII, MEI (Gold Seal)

TOTAL HOURS: 3000

AIRCRAFT TYPE(S): Cessna 310, Cessna 340, Piper Navajo

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: Texas A&M University, B.S. 1962, M.S. 1964,
Ph.D 1968, Meteorology

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
AWS forecaster (5 yrs); Chairperson - National Weather Assoc's Committee on Aviation; Aviation Editor - National Weather Digest

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Gov't research meteorologist (Atmo Sci Lab, AZ; Meteorological Satellite Lab, D.C.; NASA Earth Resources Lab, MS) Certified Consulting Meteorologist

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Eight years experience as a certified flight instructor. I have given flight instruction for Private, Commercial and Airline Transport Pilot Licenses and for instrument, multiengine, and certified flight instructor ratings, Professor, Metropolitan State College, CO.

TEXTBOOK USED: FAA Flight Training Guide

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Have taught MTR 346-3 "Meteorology and Flight Operations" every semester since 1979. This is a upper division course which I developed to train pilots at the commercial/instrument rating level. TEXTBOOK: Weather for Aircrews, Dept. of Air Force; Aviation Weather Services, FAA & NWS.

NAME: Robert J. Buchanan

TITLE: CW4 Operations Officer FDS. Instructor pilot & instrument examiner.

ORGANIZATION: United States Army Aviation Center and Ft. Rucker
Dept of Gunnery and Flight Systems
ADDRESS: Flight Simulator Division
Ft Rucker AL 36362

**PHONE: (205) 255-2480
AV 558-2480**

FLYING EXPERIENCE:

MILITARY: RATING: R/W & F/W **INSTRUCTOR:** YES
HOURS: 5,500+ **AIRCRAFT:** R/W & F/W

CIVILIAN: FAA RATINGS: Airplane SEL, MEL Rotorcraft, Instrument
Airplane & R/W

TOTAL HOURS: 600+ Commercial pilot F/W & R/W, CFII F/W & R/W

AIRCRAFT TYPE(S): Type Rating SK-58

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES:

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
I have taught informal courses on Weather related subjects, i.e. METAR,
Pressures & Winds. Station models Fronts, etc.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Thomas Q. Carney

TITLE: Professor and Associate Department Head

ORGANIZATION: Department of Aviation Technology, Purdue University

ADDRESS: Hangar #1, Purdue University Airport
West Lafayette In 47906

PHONE: (317) 743-3896

FLYING EXPERIENCE:

MILITARY:	RATING:	INSTRUCTOR:
	HOURS:	AIRCRAFT:

CIVILIAN: FAA RATINGS: Airline Transport Pilot, Airplane Multiengine Land (Commercial Pilot Privileges, Airplane Single-engine Land), Mu300/BE400 Type Rating; Certified Flight Instructor, Airplane Single-and Multiengine, Instrument-Airplane; Basic, Advanced and Instrument Ground Instructor.

TOTAL HOURS: 5487; 3797 single-engine, 1690 multiengine;
147 turbine.

AIRCRAFT TYPE(S): King Air (C90), Mitsubishi Diamond IA,
numerous Piper and Cessna singles and twins.

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: M.S., Aviation Climatology, Purdue University, 1977; Ph.D., Atmospheric Science, Purdue University, 1984.

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
16 years of experience in teaching collegiate aviation lecture courses in advance and instrument operations, and aviation meteorology.
Principal investigator for an FAA Airway Science grant to develop an operational and teaching weather laboratory. FAA Accident Prevention Counselor.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: A.A.S. in General Aviation Flight Technology, Purdue University, 1970; B.S. in Professional Pilot Technology, Purdue University, 1971.

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Faculty member in the Department of Aviation Technology, teaching flight and lecture courses, since 1972.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Type-rated in Diamond I, IA, II and Beechjet turbojet aircraft; currently flying as pilot in command in Diamond IA and ass pilot in command and instructor pilot in King Air (C90) aircraft.

NAME: Richard Drummond

TITLE: Aviation Safety Inspector, FAA

ORGANIZATION: Denver Flight Standards

ADDRESS: Denver CO

PHONE: (303) 340-5473

FLYING EXPERIENCE:

MILITARY: RATING: Pilot (Navy) INSTRUCTOR: No
HOURS: 1800 AIRCRAFT: S2F

CIVILIAN: FAA RATINGS: ATP

TOTAL HOURS: 16,000

AIRCRAFT TYPE(S): 707, 727, 737, DC-9 BAC 111

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Meteorology, Parks College

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Navy Aerologist (1 1/2 years) - Lab Assistant, Parks College
(Meteorology)

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Taught "Meteorology and Flight Ops" (3 Sem Hrs), Metropolitan
State.
Frontier Horizon - company meteorology instructor.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Donald Edward Eick

TITLE: Manager Meteorology and Administration

ORGANIZATION: Trans World Airlines, Inc.

ADDRESS: Suite 235, Hangar 12
JFK International Airport
Jamaica NY 11430

PHONE: (719) 917-4466

FLYING EXPERIENCE:

MILITARY: RATING: INSTRUCTOR:
HOURS: AIRCRAFT:

CIVILIAN: FAA RATINGS: Private Pilot, Aircraft Dispatcher

TOTAL HOURS: 500

AIRCRAFT TYPE(S): Single engine land. C-172, C-152, M-20C

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: Bachelor of Science in Meteorology, Florida State University, April 1984

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

1. Manager Meteorology for Trans World Airlines. Provides technical support to Part 121 Air Carrier in Meteorology and related weather support functions, including aviation forecasts for terminals, enroute as well as severe weather alerts. Provide weather briefing to staff, dispatch and other operating dept.
2. Meteorology Instructor. Developed, presented weather instruction to all phases of Part 121 training courses. In addition, instruct in an initial 75HR course for certification of Aircraft Dispatchers in meteorology.
3. Supervised weather faculty for flight line E-RAU as well as provided secondary meteorological instruction.
4. Staff Meteorological Assistant at Florida State Met Dept.
5. Synoptican Mesoscale Air-Sea Interaction Group Florida State Univ.
6. Representative of TWA to the Meteorological subcommittees of ATA/IATA.
7. Weather circuit coordinator of the FAA 604 and 135.
8. Past President of the student chapter of the AMS at Florida State.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

Bachelor of Science in Aeronautical Studies, Embry-Riddle Aeronautical University Daytona Beach, FL, April 1981.
Attended ground school for B-727 Flight Engineer. Completed

Commercial/Instrument.

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

1. Part 121 Air Carrier: Initial, recurrent, refresher, difference, upgrade training, and international meteorology programs.
2. Initial Aircraft Dispatcher Meteorology Program. FAA approved school which included 75 hours of instruction on all phases of aviation weather.

TEXTBOOK USED: Aviation Weather (ACOO-6A) and Aviation Weather Services (ACOO-45C)

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Background from aviation oriented university as well as a meteorological university, 10 years in aviation weather support.

NAME: Col George L. Frederick Jr

TITLE: Commander

ORGANIZATION: 3rd Weather Wing

ADDRESS: Offutt AFFB NE 68113-5000

PHONE: AV 271-4425/3706

FLYING EXPERIENCE:

MILITARY: RATING: N/R
HOURS: 12

INSTRUCTOR:
AIRCRAFT: T-37

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: Special Grad School: UCLA Met 1964-65;
Masters Degree: University of Wisconsin - Meteorology 1967-1969.

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
24 years of military weather service with duty as weather forecaster,
chief forecaster, det commander, staff meteorologist, Hq Staff Officer,
squadron commander, weather central forecasting division chief, wing
commander.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: Past Vice-President (1981)
and Past President (1986) of National Weather Association (NWA). NWA
Member of the Year 1986. Professional member of American
Meteorological Society since 1968. Participated in numerous
conferences on meteorology.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: BS Engineering
Science USAF Academy

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Taught numerous weather portions of instrument refresher course, FAA
certification classes for private pilots, and weather topics at flying
safety meetings.

TEXTBOOK USED: Weather for Aircrues and others.

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Began USAF career as a student pilot--was withdrawn from training for
medical reasons (hearing loss from T-37) after only 12 hours of flight
time but over 6 months of academics including 44 hours of weather
training. That exposure plus my desire to remain close to aviation,
motivated me to seek a career in meteorology.

NAME: Capt Bartlett C. Hamilton II

TITLE: Scientific Services Officer

ORGANIZATION: 5WW/DNS

ADDRESS: Langley AFB VA 23665

PHONE: AV 574-5901

FLYING EXPERIENCE:

MILITARY:	RATING	INSTRUCTOR YES OR NO
	HOURS	AIRCRAFT
CIVILIAN:	FAA RATINGS:	Private
	TOTAL HOURS:	500
	AIRCRAFT TYPE(S):	SE Fixed Gear

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Meteorology, Univ of Utah 1978; M.S. meteorology, Creighton University, Omaha 1983.

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Forecaster for 50 Bases/Day at AFGWC 1979
Aircraft Accident Board 1986
Quality Control of Basic Meteorological Analysis Techniques

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: Air Pollution Staff Meteorologist

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Working on a Masters in Education.

NAME: James P. Johnson

TITLE: Meteorological Consultant

ORGANIZATION: James Johnson Associates

ADDRESS: 739 Echo Lane
Glenview, Illinois 60025

PHONE: (312) 729-3100

FLYING EXPERIENCE:

CIVILIAN: FAA RATINGS:

Flight Instructor--Instrument Airplane; Ground Instructor--Advanced & Instrument; Airframe & Powerplant Mechanic; Aircraft Dispatcher; Flight Engineer--Turbojet; Appointed FAA Accident Prevention Counselor--Great Lakes Region; FAA Designated Check Airman -- Delta Air Lines.

TOTAL HOURS: 10,500.

AIRCRAFT TYPES: Cessna/Piper SEL & MEL; B-18; DHC-6 Twin Otter; HP-35; B-A100 King Air; C-500; DC-9; B-727.

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES:

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

--see Educator/Training Experience

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

--see Educator/Training Experience

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

Associate of Science: Aeronautical Engineering

Bachelor of Science: Aeronautics

Parks College of Saint Louis University

Air Line Pilot's Accident Investigation School-San Diego

National Business Aircraft Association's Airborne Radar Course

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

Faculty Member-Parks College of Saint Louis University
Aviation Sciences Department
Meteorology Instructor--Harper College Palatine, Illinois

Director of Meteorological Training--Aeronautical Training Programs
Schaumburg, Illinois

Lecturer and workshop leader on aviation weather for the Illinois
Department of Transportation; Federal Aviation Administration; and
the Experimental Aircraft Association (EAA).

Instructor for Aviation Meteorology seminars for 12 years.

TEXTBOOK USED: Meteorology Today, Ahren
The Science and Wonders of the Atmosphere, Gedzelman.

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

Full Member-American Meteorological Society (AMS)
Full Member-American Institute of Aeronautics and Astronautics (AIAA)
Member--National Weather Association (NWA)
Member of ALPA National Aviation Weather Committee
Meteorological Specialist on Delta--ALPA Accident Investigation Team
Active Member-Aviation/Space Writers Association (AWA)
Contributing Author to World Book Encyclopedia

PUBLICATIONS:

Pilot's Handbook of Hazardous Weather
Thunderstorms
Bing Crosby, Top 20 and Dreams (article on snow)
Weather Safety tips for Recreational Activities
The Radar Summary Chart
Sheer Madness
Clouds: Signposts in the Sky

Meteorological Consultant to:

Peterson, Ross, Schloerb & Seidel--Law Firm, Chicago, Illinois
McCullough, Campbell & Lane--Law Firm, Chicago, Illinois
Illinois State Police
Illinois State's Attorney's Office, McHenry County, Illinois
Professional Association of Diving Instructors (PADI)--California
Senechalle & Murray--Law Firm, Arlington Heights, Illinois
Lord, Bissell & Brook--Law Firm, Chicago Illinois
Philip Prossnitz & Associates--Law Firm, Evanston, Illinois
Alfred A. Beardmore, Attorney, Charles City, Iowa
Don Minelli & Associates--Film Producer, Chicago, Illinois
Richard Mack Photography--Location Photographer, Evanston, Illinois
Robert Hartl Photography--Location Photographer, Highland Park, IL

NAME: Capt Georges B. Kleinbaum

TITLE: Chief, Aviation Wx Programs, Meteorological Methods Division

ORGANIZATION: HQ AWS

ADDRESS: HQ AWS/DNTM
Scott AFB IL 62225-5008

PHONE: (618) 256-4741
AV 576-4741

FLYING EXPERIENCE:

MILITARY:	RATING: AC	INSTRUCTOR: NO
	HOURS: 1000	AIRCRAFT: H-3E

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Meteorology, SUNY Oswego (NY) 1979

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Only working in AWS.

NAME: Carl R. Knable

TITLE: Manager - Meteorology

ORGANIZATION: United Airlines

ADDRESS: P.O. Box 66100
Chicago IL 60666

PHONE: (312) 952-6301

FLYING EXPERIENCE:

MILITARY: RATING:
 HOURS:

INSTRUCTOR:
AIRCRAFT:

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Math, Univ of Ill. 1964
 B.S. Meteorology, Univ of Utah 1965

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Air Weather Service - Weather Officer (Briefer, Chief Forecaster,
 Detachment Commander).

United Airlines - 20 years, flight operations support.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: N/A

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
USAF ground school, United Airlines recurrent training for flight
 dispatchers.

TEXTBOOK USED: "Meteorology Today", C. Donald Ahrens (Dispatch
 training).

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Major Ron Liddell

TITLE: Chief, Trainer Programs

ORGANIZATION: USAF Instrument Flight Center

ADDRESS: Randolph AFB TX 78150-5000

PHONE: AV 487-3077

FLYING EXPERIENCE:

MILITARY: RATING: Command Pilot INSTRUCTOR: Yes
HOURS: 2400 AIRCRAFT: T-37

CIVILIAN: FAA RATINGS: SEL, MEL, Instrument, Commercial

TOTAL HOURS: 2000

AIRCRAFT TYPE(S): SE & ME Light Aircraft

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES:

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:
BS Physics; BS Mathematics

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
UPT & Instructor Pilot Training (PIT) Instructor

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Responsible for the Air Force Pilot's Instrument Refresher Course. Taught instruments and weather subjects to Active Duty, Reserve, and Air National Guard crew members at over 90 sites in four countries.

NAME: Bob Massey

TITLE: Vice Chairman, Aviation Weather Committee (AWX)

ORGANIZATION: Airline Pilots Association (ALPA)

ADDRESS: P.O. Box 1169
Heandon VA 22070

PHONE: (714) 337-3657

FLYING EXPERIENCE:

MILITARY:	RATING: Pilot	INSTRUCTOR: No
	HOURS: 2500	AIRCRAFT: C141 A/B

CIVILIAN: FAA RATINGS: ATP, COMML SMEL

TOTAL HOURS: 7,000

AIRCRAFT TYPE(S): B727, A310, DC-8

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Meteorology, Univ Wis, 1971

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Active with AWX in participating on industry projects and task forces. (TDWR, ELLWS, NEXRAD Etc)

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: M.S. Aviation Safety,
Univ Southern Calif, 1976

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Graduate instructor for Embry Riddle Univ.
Courses - Airline OPS/MGMT; Advanced Topics in Meteorology

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: C. Elaine McCoy, Ph.D.

TITLE: Assistant Professor

ORGANIZATION: Ohio State University, Dept of Aviation

ADDRESS: Box 3022
Columbus OH 43210

PHONE: (614) 292-5460

FLYING EXPERIENCE:

MILITARY: RATING:
HOURS: INSTRUCTOR:
AIRCRAFT:

CIVILIAN: FAA RATINGS: ATP-ME CFIAI

TOTAL HOURS: 1700

AIRCRAFT TYPE(S): Miscellaneous

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: Ph.D. Communication Ohio Univ. '81
M.A. Ohio State, 1972

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

Aviation weather course instructor - OSU, 4 years
Weather related research - FAA/DOT/CODI Rockwell
NASA/CODI Smith

8th Annual Workshop on Meteorological and Environmental Inputs to
Aviation Systems University of Tenn Space Institute 1985.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Capt Timothy Miner

TITLE Assistant Professor and Head of Geography

ORGANIZATION: Department of Economics and Geography

ADDRESS: United States Air Force Academy, Colorado 80840-5701

PHONE: (719) 472-3067
AV 259-3067

FLYING EXPERIENCE:

MILITARY:	RATING: Sr. Pilot	INSTRUCTOR: Yes
	HOURS: 2010	AIRCRAFT: KC-135, T-41, T-38

CIVILIAN: FAA RATINGS: Commercial/Instrument, ATP-ME

TOTAL HOURS: 50

AIRCRAFT TYPE(S): Various single & multi engine

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Geography (Physical)-USAFA
M.A. Geography (Climatology-Cartography)
Ohio State

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Qualified Air Force weather officer. Only AF pilot (never assigned to AWS) to wear AF Professional Meteorologist Badge. Member-National Weather Assoc's Committee on Aviation.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Developed Interactive Videodiscs for training NWS/AWS personnel NEXRAD technology.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: B.S. Computer Science
Chapman College

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

Developed and taught meteorology courses and program at USAFA.
Developed, wrote, and filmed "graduate meteorology" program (video tape-workbook) for Strategic Air Command pilots. Developed planetarium show for all freshmen cadets at USAFA to learn fundamentals of aviation meteorology.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Major Mark E. Older III

TITLE: Chief, Requirements and Resources Section

ORGANIZATION: 7th Weather Wing

ADDRESS: Scott AFB IL

PHONE: AV 576-5867

FLYING EXPERIENCE:

MILITARY:	RATING: Navigator	INSTRUCTOR: No
	HOURS: 1250	AIRCRAFT: C-141A

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: M.S. Meteorology, U.S. Naval Postgraduate School, 1981
Basic Meteorological Training, Texas A&M University, 1976
B.S. Mathematics, University of Michigan, 1972

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Commander, Detachment 4, 17th Weather Sq, Altus AFB OK, 1985-1988
Weather Observer, Det 33, 26 Wea Sq, K.I. Sawyer MI, 1965-1967

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Typhoon Forecaster, Joint Typhoon Warning Center, Guam, 1983-1985
Staff Meteorologist to Space Division, Los Angeles CA, 1981-1983
Forecaster, Air Force Global Weather Central, Offutt AFB NE, 1977-1979
Meteorological Satellite Specialist, Republic of Viet Nam, 1967-1968

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Current duties include staff weather support to Hq Military Airlift Command. When I was flying, I was a Lead Combat Airdrop Navigator. I consider my meteorological expertise to be in the following fields: Tropical Meteorology, Radar Meteorology, Satellite Operations, Severe Weather Forecasting, Numerical Weather Prediction, and Remote IR Sensing. I am a Master Meteorologist and wear the USAF Space Badge.

NAME: Michael R. Poellot

TITLE: Associate Professor

ORGANIZATION: Department of Atmospheric Sciences

ADDRESS: University of North Dakota
Box 8216 University Station
Grand Forks ND 58202

PHONE: (701) 777-3180

FLYING EXPERIENCE:

MILITARY:	RATING:	INSTRUCTOR:
	HOURS:	AIRCRAFT:

CIVILIAN: FAA RATINGS: Commercial, Single & Multiengine, Instrument,
Advanced Ground Instructor

TOTAL HOU.S: 1150

AIRCRAFT TYPE(S): Cessna Citation Type

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: M.S., Atmospheric Sciences, Colorado State
University, 1975

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Have been involved as scientist and co-pilot on airborne research
missions in the study of thunderstorms, aircraft icing, wind shear
and turbulence.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Analysis of digital radar data and cloud microphysical data.
Operational public weather forecasting.
Weather modification field operations.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Teaching college courses in Aviation Meteorology. Subject matter
expert in meteorology for Northwest Aerospace Training Corporation
ab initio pilot training program. Training pilots for weather
modification operation.

TEXTBOOK USED: Aviation Weather, Aviation Weather Services

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Kendall L. Roose

TITLE: Education Specialist

ORGANIZATION: Training Air Wing Five

ADDRESS: NAS Whiting, Milton FL 32570

PHONE: (904) 623-7659
AV 868-7659

FLYING EXPERIENCE:

MILITARY: RATING: INSTRUCTOR:
HOURS: AIRCRAFT:

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: BA - University of West Florida
MA - Webster University

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
NAVAIRTRACOM Curriculum Model Manager for seven years

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: NA

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS: NA

TEXTBOOK USED: Navairtracom Meteorological Theory & Meteorology Flight
Planning

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

1983/84 Meteorology Job/Training Analysis Survey

1983/84 Meteorology Curriculum Development Committee Coordinator

NAME: Wayne Sand

TITLE: Deputy Manager, Research Applications Program

ORGANIZATION: NCAR

ADDRESS: P.O. Box 3000
Boulder CO 80308-3000

PHONE: (303) 497-8654

FLYING EXPERIENCE:

MILITARY: RATING: U.S. Navy INSTRUCTOR: NO
HOURS: 1300+ AIRCRAFT:

CIVILIAN: FAA RATINGS: SEL, MEL, INST, FLT. INSTRUCTOR

TOTAL HOURS: 6000+

AIRCRAFT TYPE(S): BE-200, IAE, C-414, BE-80, A6A, A4,
F9, T2, C-210, C-182, PA-24, PA-30 ETC.

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: PhD Atmospheric Science, MS 1975 SDSM&T,
PhD 1980 Univ of WY

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Taught basic undergraduate meteorology at the University of Wyoming and
the U.S. Naval Academy Weather research flying for 20 years. Weather
modification research and flying 10 years.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: Thunderstorm research and
flying. Aircraft research and flying. Microburst and wind shear
research and flying. Winter storm research and flying.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: James T. Skeen, Jr.

TITLE: Evaluations Officer

ORGANIZATION: Aviation Services Branch
 National Weather Service Headquarters
ADDRESS: 8060 13th Street
 Silver Spring, Maryland 20910

PHONE: (301) 427-7726

FLYING EXPERIENCE:

MILITARY: RATING: Aircrew **INSTRUCTOR:** NO
HOURS: 1800 **AIRCRAFT:** WC130-H

CIVILIAN: FAA RATINGS: None

TOTAL HOURS: N/A

AIRCRAFT TYPE(S): N/A

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: U.S. Air Force Academy 1971; North Carolina University, Raleigh, NC 1972.

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
4 years aviation forecaster U.S. Air Force; 3 years aviation advisory meteorologist, NWS; 6 years Aviation Services Branch, NWS; 12 years U.S. Air Force Reserve Aerial Reconnaissance Weather Officer.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: 3 year polar oceanography research and development.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: N/A

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS: Seminars with Air Force pilots. FAA controllers training.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Colonel Richard J. Vogt

TITLE: Director of Operations

ORGANIZATION: 4WW/DO, Stop 13

ADDRESS: Peterson AFB CO 80914-5000

PHONE: 554-7506

FLYING EXPERIENCE:

MILITARY:	RATING:	INSTRUCTOR:
	HOURS:	AIRCRAFT:

CIVILIAN: FAA RATINGS: CFII

TOTAL HOURS: 700

AIRCRAFT TYPE(S): SEL

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: M.S. in Meteorology, Texas A&M, 1972

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
20 years in Air Weather Service as forecaster, briefer, operations officer, and commander of unit supporting a wide variety of military flying operations throughout the world.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: B.S. in Education,
SW Okla St Univ

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
CFI and CFII, 290 hours; ground school instructor; aviation meteorology presentations to military safety and instrument flying classes.

TEXTBOOK USED: Various commercial flight instruction materials; AC 00-6 (Aviation Meteorology); AFP 51-12, Vols 1 & 2 (Weather for Aircrews)

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Frank E. Wencel, Lt Col, Ret.

TITLE: Professor, Aeronautical Science

ORGANIZATION: Embry-Riddle Aeronautical University

ADDRESS: Daytona Beach FL 32014

PHONE: (904) 239-6444

FLYING EXPERIENCE:

MILITARY: RATING: Master Navigator INSTRUCTOR: Yes
HOURS: 4200 AIRCRAFT: T-29/C-54/C-123

CIVILIAN: FAA RATINGS: Instrument Ground Instructor

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.S. Meteorology, Texas A&M University, 1960;
M.S. Meteorology, University of Oklahoma,
1968.

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
4 years taught meteorology in USAF Navigator Training School.
15 1/2 years teaching meteorology at Embry-Riddle Aeronautical University.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: Strategic Air Command Alert Force Briefing Officer - 2 years. Strategic Air Command Weather Detachment Commander - 4 years.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: 30 Credit Hours toward doctorate in education.

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS: Have taught ERAU courses in Navigation, Flight Rules & Regulations, Flight Physiology, Taught USAF Annual Instrument Course, Air Navigation at USAF Navigator Training School 8 years.

TEXTBOOK USED: Meteorology Today - Ahrens

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Have co-authored one hour ERAU Computer Based Tutorial on the Hourly Weather Report. One year combat flying in Vietnam in low level spray operations.

NAME: Capt Larry J. White

TITLE: Instructional Program Developer

ORGANIZATION: HQ ATC/3305 School Sq

ADDRESS: Randolph AFB TX 78150-5000

PHONE:

FLYING EXPERIENCE:

MILITARY: RATING: INSTRUCTOR:
HOURS: AIRCRAFT:

CIVILIAN: FAA RATINGS: Private

TOTAL HOURS: 250

AIRCRAFT TYPE(S): C-150, C-172, C-182, PA-180

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: B.A. Earth Science (Met), University of No. Colorado; MPA Environmental Management

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Forecaster, Travis AFB; Weather Instructor, UPT, Williams AFB;
Weather Courseware Developer for UPT, Randolph AFB

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: N/A

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: N/A

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS: N/A

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
N/A

NAME: Ivan A. K. Friend

TITLE: Current Operations Officer

ORGANIZATION: 24th Weather Squadron/ATC DOW

ADDRESS: Randolph AFB, TX 78150-5000

PHONE: (512) 652-5080
AV 487-5080

FLYING EXPERIENCE:

MILITARY: RATING: Crew Member INSTRUCTOR: YES EVALUATOR: YES
HOURS: 817 AIRCRAFT: EC-135

CIVILIAN: FAA RATINGS: None

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: BS Management, Univ of Nebraska, '80
As Weather Observing Technology, CCAF, '80

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
Provided planning and mission forecast weather for trans-Pacific SEA fighter aircraft at PACAF. Base Weather Station Forecaster; Wing Weather Officer; Assistant Chief, Weather Support Unit (15th Air Force); Chief, Special Missions Branch, Strategic Reconnaissance Center, HQ SAC; Staff Weather Officer to U.S. Army 1st Armored Division (Air CAV; Combat Aviation Brigade).

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Weather Observer Technical Training, Chanute AFB, IL
Weather Forecaster Technical Training, Chanute AFB, IL
Tropical Southern Hemisphere Forecast Unit, AFGWC, Offutt AFB, NE
METSAT Coordinator, 9th Weather Squadron, March AFB, CA
RADAR Coordinator, 9th Weather Squadron, March AFB, CA

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: Near completion of Masters in Aeronautical Science

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:
Evaluator, Instructor, SAC Airborne Command Post Weather Officer Project Officer in Survivable Endurable Weather concept.
Staff Assistance in weather support provided to SAC Strategic reconnaissance aircraft at RAF Mildenhall; RAF Alconbury; Osan AB; Kadena AB, Beale AFB.

NAME: Lt Col Robert S. Hey

TITLE: Chief, SAC Instrument Flight Course

ORGANIZATION: 330 CFIS/DOI

ADDRESS: Castle AFB, CA 95342-5000

PHONE: (209) 726-4571
AV 347-4571

FLYING EXPERIENCE:

MILITARY: RATING: Pilot INSTRUCTOR: YES
HOURS: 3300 AIRCRAFT: T-37,T-38,T-39,KC-135

CIVILIAN: FAA RATINGS: Commercial Instrument

TOTAL HOURS: 100 hours

AIRCRAFT TYPE(S): Light airplanes

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES:

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
I've taught the Enroute Weather course at the SAC Instrument Flight Course.

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Major Douglas C. Pearson

TITLE: Commander

ORGANIZATION: Det 9 5th Weather Squadron

ADDRESS: Fort Rucker AL

PHONE: (205) 255-3902
AV 558-3902

FLYING EXPERIENCE:

MILITARY: RATING:
HOURS: INSTRUCTOR:
AIRCRAFT:

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S):

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: University of Texas/Basic Meteorology
Program/1973-1974
University of Wisconsin, Madison WI,
Masters Degree, 1980-82

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

Aviation support to SAC, 1974-77, KI Sawyer AFB, MI
Instructor for aviation meteorology course (UPT Program), 1977-1980
Sheppard AFB, TX
Meteorological and aviation support to forces in Latin America,
1985-1988, 45 Southern, Panama
Commander of weather detachment supporting Army Aviation Training,
1988-present, Ft Rucker AL

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

Member of the AMS
Previous part time work with the State Climatology office in East
Lansing Michigan, 1971-73.
Summer work setting-up weather equipment with the Univ of Mich 1972.

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:
ATC Instructor Training Course 1977
Masters Degree in Education from the University of Oklahoma 1979

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Weather briefings and Flight safety meetings throughout career.
Instructor of Aviation Meteorology for 3 years/taught U.S. German
and Iranian student pilots.

TEXTBOOK USED: ATC course material which I developed/reworked.

NAME: Jack W. Rachels

TITLE: Chief, Bomber Training Branch

ORGANIZATION: 436 STS (Strategic Training Squadron)

ADDRESS: Carswell AFB, TX 76127-5000

PHONE: AV 739-7379

FLYING EXPERIENCE:

MILITARY:	RATING: Cmd Pilot	INSTRUCTOR: YES
	HOURS: 3500	AIRCRAFT: B-52 D, G, H

CIVILIAN: FAA RATINGS: Commercial/Instrument

TOTAL HOURS: 300

AIRCRAFT TYPE(S): Cessna 150, 152, 172, Piper Arrow

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: None related to meteorology

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: Human Relations & Supervision (MA)

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:
Standard SAC instructor pilot duties.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

- Computer Based Training Designer's Course
- Criterion Referenced Instruction (Mager & Pipe)
- Instructional Systems Design (ATC)

I know how to design, structure, and produce courseware in any training media from paper to full simulation, including Computer Based Training, Tape-Slide, Filmstrip, and Videotape media.

NAME: Lt Col Ronald J. Sergott

TITLE: Chief Operational Support Division

ORGANIZATION: HQ MAC/Directorate of Training

ADDRESS: Scott AFB IL 62225-5001

PHONE: AV 576-3906/2776

FLYING EXPERIENCE:

MILITARY: RATING: Command Pilot **INSTRUCTOR:** Yes
HOURS: 3700 **AIRCRAFT:** C-47/T-37/H-1

CIVILIAN: FAA RATINGS:

TOTAL HOURS:

AIRCRAFT TYPE(S) :

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: N/A

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE:

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING:

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS:

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

NAME: Major John R. Voss

TITLE: F-15 Functional Manager

ORGANIZATION: HQ TAC/DOOF (FTR Management Division)

ADDRESS: HQ TAC/DOOF
Langley AFB VA 23665-5000

PHONE: AV 574-7785

FLYING EXPERIENCE:

MILITARY: RATING: Senior Pilot **INSTRUCTOR:** Yes
HOURS: 2700 **AIRCRAFT:** F-15/T-37

CIVILIAN: FAA RATINGS: Comm Pilot/Instructor

TOTAL HOURS: 300

AIRCRAFT TYPE(S): Airplanes single engine land and sea

METEOROLOGICAL EXPERIENCE:

RELATED COLLEGE DEGREES: None

DESCRIBE ANY EXPERIENCE IN AVIATION METEOROLOGY OTHER THAN FLYING:
None

DESCRIBE ANY OTHER METEOROLOGY EXPERIENCE: None

EDUCATOR/TRAINING EXPERIENCE:

NON-METEOROLOGICAL DEGREES WHICH ADD TO TRAINING: MBA in Aviation Management

EXPERIENCE TRAINING AVIATION OR AVIATION METEOROLOGY TOPICS: FAA Flight Instructor and former ATC instructor.

TEXTBOOK USED:

OTHER SIGNIFICANT TRAINING OR EXPERIENCE WHICH ADDS TO THIS CONFERENCE:

THE WORKINGS OF THE CONFERENCE

The Professional Pilots' Meteorology Training Standards Conference began on 13 April 1989 at 0800 in the academic building of the United States Air Force Academy, Colorado. Although the attendees were present for only a day and one-half, the work began a month prior and lasted for two months after the conference.

The opening session for all 30 attendees began with a welcome by Colonel Raymond E. Franck, Jr., the Head of the Department of Economics and Geography.

The moderator, Captain Timothy Miner, Assistant Professor and Acting Head of Geography, then explained the purpose and methodology of the conference. The agenda of the conference was to accomplish the tasks of identifying the minimum standards for professional pilot meteorology training, and promoting dialogue between individuals and organizations with aviation meteorology training interests. The focus of the conference was the "professional" pilot--defined as any pilot with a commercial-instrument civilian flight rating, or any graduate of a military flight training school.

There were three keynote presentations during the first working session of the morning. Colonel George L. Frederick, Jr., discussed the meteorology training provided in the Air

Force. Then Mr Robert Massey discussed civilian pilots and their weather training programs. Professor Frank Wencel then discussed the programs that are available in the university flight training programs.

Prior to the conference the attendees reviewed a list of objectives that could be used to train meteorology to a professional pilot. This initial list was actually developed from the U.S. Navy's extensive educational assessment study of its aviation meteorology training. Members freely added to the list. By the time of the conference, the initial list grew to a revised list of over 220 learning objectives (Appendix A2).

The fourth presentation of the morning session was by Mr Kendall Roose, an educational specialist from the U.S. Navy's Training Wing Five. He discussed the methodology that produced the Navy's list of training objectives. There was an initial survey conducted by the Navy of pilots from many different weapon systems. This survey produced a list of training objectives for each weapon system which was then assessed by instructors and meteorologists for validity. The results of the survey after being validated resulted in a twenty-five percent decrease in the number of hours devoted to meteorology training down to the current thirty hour program. Mr Roose discussed the validation process and the success the Navy felt it derived from their study.

The second working session had the entire group begin a

review of the conference-revised training objectives. This effort attempted to duplicate the validity process of the U.S. Navy. Initially the conference as a whole evaluated the first two pages of objectives by deciding which objectives were "critical", "nice-to-know", and "unnecessary for a professional pilot to know." After the initial combined session so that everyone could "feel out the mood of the collective body," the conference was divided into three working groups with the same proportion of specialties as the whole body. These working groups then divided the remaining parts of the revised list of objectives and evaluated them. All "unnecessary" items were deleted from the list and wording changes were made where necessary.

A working lunch for the group began the second goal of the conference. Informal dialogue began between individuals and organizations on the expectations and needs of pilots and meteorologists.

This dialogue then became formal during the late afternoon session when civilian and military members separated to promote discussions on the needs for pilot meteorology training within each arena. Each group provided the conference with a list of goals and recommendations. Major Ron Liddell of the U.S.A.F. Instrument Flight Center led the military group's discussion. The civilian group had Mr Robert Massey for a moderator.

The second morning brought the entire conference together.

For most of the morning the three working groups presented their evaluations with the conference and discussed differences. The second session of the morning was a review of the conference, and a discussion of the current status of programs and research in the National Weather Service, the Air Weather Service, and at the National Center for Atmospheric Research which would directly impact the future of meteorology training for pilots. Mr James Skeen, Colonel George Frederick, and Dr Wayne Sand respectively gave these presentations. The final presentations were from the civilian and military working groups which presented their conclusions and recommendations for discussion.

The conference's last discussion was on the future of this body of organizations and individuals. Both working groups had already decided that they were going to work on their own agendas. The conference expressed an interest in another meeting for the whole body, again at the Air Force Academy, in about one year.

The conference ended about noon on Friday, 14 April 1989, but the work continued through the summer. Captain Miner collected and published the final list of training objectives. This objective list then went to all attendees who returned dissenting opinions on various objectives. These dissenting opinions are considered part of the final product of the conference and are included with the results.

The Professional Pilots' Meteorology Training Standards

Conference was a multi-organizational and multi-disciplinary attempt to develop a standardized and specific training curriculum for all professional pilots in meteorology. It was also an attempt to integrate and coordinate various activities in this area, and to facilitate a dialogue between pilots and meteorologists. Both of these goals were successful, but there is still work to be done to improve pilot meteorology training.

RESULTS OF THE CONFERENCE

The Professional Pilots' Meteorology Training Standards Conference produced two results--a standardized list of training objectives and recommendations for the future from the civilian and military working groups.

The standardized list of training objectives begins on page 5-3. Marked objectives indicate the "critical-need to know" items for all professional pilots. These are the learning objectives that must be taught to the pilot to accomplish safety of flight and fundamental skills in weather-oriented decision-making. The unmarked objectives are "nice-to-know" and desirable because they allow a pilot to understand the fundamental processes of the atmosphere that help make less critical decisions in flight.

Because of the strong influence of the military pilots in the conference, there was a desire to specifically limit the weather training to only weather theory. The group voted down "operational" concepts such as "how to fly through certain conditions" because that is not currently taught in the "weather" training in the military. There were very strong objections to this by the university professors who were horrified at the prospect of taking the "relavancy" aspect of the training out of this training objective list. It is their belief that if the "how-it-applies" aspect is removed from the course then the

student pilot will never get it anywhere else, and any weather theory would lose its value. It is the editor's opinion that this is the single fundamental weakness of the results of the conference.

There was also a tendency to limit the theoretical knowledge taught in the objectives. The strong pilot orientation kept the group focused on just what is needed by the professional pilot to fly. There was some dissension by the meteorologists, but they were strongly influenced by the pilots at the conference.

The dissenting opinions immediately follow the conference's list of objectives, beginning on page 5-10.

The second objective of the conference was to make recommendations for the future to improve or change pilot meteorology training. These lists, both military and civilian, begin on page 5-18.

CONFERENCE REVISED METEOROLOGY OBJECTIVES
* - CRITICAL INFORMATION

1. General Structure of the Atmosphere

1. * Describe the two lower layers of the atmosphere and their boundary.
2. State the composition of the atmosphere.
3. * State the six elements of weather that a pilot may encounter in flight--temperature, pressure, wind, humidity, clouds, precipitation, aerosol.
4. * State the primary hazards to flight. (turbulence, low level wind shear, hail, icing, low ceiling, low visibility, thunderstorm, lightning).

2. Atmospheric Temperature

1. State and define the primary source of all weather as insolation.
2. Define specific heat and explain how it affects the warming of the earth's surface. (e.g. differential heating of land/water and thermal turbulence).
3. State and define the methods of heat transfer and relate it to convection, turbulence, etc.
4. * Define the International Standard Atmosphere.
5. * State the standard lapse rate in Celsius.
6. * State and define the terms used to describe various non-standard lapse rates relative to the standard lapse rate and deviations from standard.
7. * Define density altitude, state its parameters and its effect on aircraft performance including effects of differential density altitude on recip & jets.
8. * Explain the importance of the adiabatic lapse rate.
9. * Know how to compute density altitude and how it is affected by pressure, temperature, and humidity changes.

3. Atmospheric Pressure

1. * Define the term atmospheric pressure.
2. * State the standards and the lapse rates used with atmospheric pressure.
3. * Differentiate between sea level pressure, station pressure, and altimeter setting and understand the manner each is measured.

4. State the types of equipment used in measuring atmospheric pressure, and their limits and accuracy.
5. * Describe the effects of temperature and pressure on altimetry and solve selected altimeter problems.
6. * State and define the different measures of altitudes with which a pilot should be familiar, including pressure and density altitude.
7. * Define pressure altitude, state its parameters and its effect on aircraft performance.
8. * Know how to compute pressure altitude and how it is affected by pressure changes.

4. Winds and Their Circulation

1. Explain global circulation and how it combines with the Coriolis Force to produce latitudinal pressure systems and prevailing wind flows.
2. * Describe selected small scale wind circulations and how they could affect flight, including cyclones, sea/land breeze, katabats, and venturi effects.
3. Demonstrate comprehension of the principles for identifying geostrophic, gradient, and friction layer winds, with respect to isobars around high and low pressure systems in the both hemispheres.
4. * Describe the jet streams, their relation to weather systems, and their seasonal migration/strength/altitude. Understand what's responsible for jet stream (polar front, subtropical, polar night), where it's found, it's influence on synoptic scale weather, and relationship to CAT.

5. Moisture

1. Understand the principle of different states of water, and latent energy during a change from one state to another.
2. State the conditions that may produce dew or frost on an aircraft.
3. Display a comprehension of the various moisture terms and their relationship to each other in the formation of clouds, fog, dew, frost and precipitation.
4. * Given examples of clouds, identify them as to form, flight characteristics, precipitation, classification and flight hazards.

6. Atmospheric Stability

1. * Define the terms stability/instability as they apply to the atmosphere.
2. * Define adiabatic process.
3. Understand effect of water vapor on stability.
4. * State the basic types of lifting.

5. Describe the conditions that must exist for conditional or convective instability.

6. Identify cloud types and flight hazards with their associated stability.

7. Air Masses

1. * Define an air mass.

2. * Describe the air mass classification system including moisture content, temperature, and source region.

3. * State the relationship between air mass temperature and stability.

4. * State the basic flight conditions in selected air masses.

5. Describe the frontal discontinuities used to locate and classify fronts.

6. * State the conditions associated with a cold front including vertical and horizontal structure.

7. * State the conditions associated with a squall line including the courses of squall lines.

8. * State the conditions associated with warm front including vertical and horizontal structure.

9. * State the conditions associated with an occluded front including vertical and horizontal structure.

10. * State the conditions associated with a stationary front including vertical and horizontal structure.

11. * State the conditions associated with a sea/land breeze front.

12. * State the color and symbol codes by which a pilot can identify a front on a locally prepared surface chart.

13. Explain the effect of terrain on the progression of air masses.

8. Thunderstorms

1. * State the requirements for thunderstorm formation and where newly developing thunderstorms are likely to form.

2. * Describe the thunderstorm life cycle and the characteristics of each stage.

3. * Describe the various hazards that are associated with most thunderstorms including triggered lightning, and those unique to severe thunderstorms.

4. * Describe the various types of thunderstorm classifications including imbedded thunderstorms including severe, steady state, squall-line thunderstorms and mesoscale convective (MCC).

5. * Explain how radar works and how it can aid a pilot in thunderstorm flight techniques. Explain the limitations of radar, explain storm-scope in detecting severe weather.
6. * State the various flight techniques that are recommended for flight near or in thunderstorms.
7. * Know windshear and microburst recognition and avoidance, and pilot techniques for escape.
8. * State limits of current terminal forecast systems for detecting and warning of thunderstorm hazards.
9. * Describe the various hazards that are associated with most thunderstorms, and the distances from the storms where these hazards can be encountered.
10. * Explain the difference between microbursts, downdrafts/updrafts, and down burst, and their influence on aircraft.
11. * Know how to circumnavigate thunderstorms using in-flight visual cues.

9. Lightning

1. * Describe natural lightning, triggered lightning and static discharge, and the environmental conditions and flight profiles most conductive to these hazards.
2. * Explain how pilots can minimize exposure to lightning and discharge conditions.
3. * Explain the hazards of lightning and discharge to aircraft operations, with emphasis on changing vulnerabilities of aircraft due to changing technologies.

10. Visibility

1. * Describe the relative effects of various precipitation types, aerosols and fog on in-flight visibility.
2. * Understand the difference between sector visibility, prevailing visibility, transmissometer visibility, in-flight visibility and slant-range visibility.
3. Describe the effect of sun position causing forward and back scatter, and how this affects visibility.
4. Understand the definitions of sunrise/sunset and morning/evening civil twilight, and the effects of night and twilight on visibility.

11. Turbulence

1. * Describe the method by which thermals create turbulence.
2. * Describe the method by which terrain creates mechanical turbulence including mountain waves and their indicators.

3. * Describe the method by which frontal lifting creates turbulence.
4. * Describe the method by which large scale wind shear creates turbulence.
5. * Describe the method by which turbulence forms, and its effects on take-offs and landings.
6. * State the terms and definitions used to describe the four intensities of turbulence and their frequency.
7. * Understand mechanism to create and minimize CAT encounter.
8. Understand the use of current and near term forecasting and observing systems for detecting and warning about on turbulence.
9. * Describe the relationship of the tropopause and turbulence.
10. * Understand how various aircraft characteristics such as size, speed, wing loading, etc., dictate a given aircraft's response to turbulent conditions, and therefore require adjustment of turbulence intensity reports from pilot reports and forecasts.

12. Windshear (Non-convective LLWS)

1. Know situations that create LLWS (inversion, land, sea breeze).

13. Icing (Inflight and Ground)

1. * State the environmental conditions most conducive to the formation of structural icing. (Inflight & Ground)
2. * State the factors affecting the accumulation of ice on aircraft.
3. * State the cumulative effects of icing on an aircraft. (Inflight & Ground)
4. * Be able to identify icing type, intensity, and clouds for reporting.
5. Describe environmental conditions and aircraft operations conducive to ice formation in aircraft fuel systems.
6. * State the environmental conditions most conducive to the carburetor induction icing on piston engines, and how it may cause engine power loss or failure. State the environmental conditions most conducive to the formation of ground induction icing for jet engines. Describe how ground induction icing may cause jet engines foreign object damage.
7. * Explain the effects of ice, snow and frost on aircraft surfaces on takeoff performance.
8. * Identify icing peculiar to various types of clouds and precipitation and runway conditions.
9. * Identify types and intensities of icing found relative to extra tropical cyclone and fronts.

10. * State the flight techniques for avoiding icing when encountering wet snow or freezing rain.

11. * Know use of current and near term forecasting and observing systems for detecting and forecasting icing.

12. * Understand icing and deicing equipment use and what FAR requires with "known icing".

13. * Know meteorological indications that tell pilot how to avoid and leave icing.

14. Fog and Low Clouds & Obscuration

1. * Define fog and low clouds.

2. * State conditions required for the formation or dissipation of the various types of fog.

3. * Define types of inversion, causes, effects on low vis events.

4. * Define the terms: obscuration, partial obscuration and vertical visibility, ceiling, clear, scattered, broken, prevailing visibility, RVR, indefinite, overcast and understand slant range versus visibility experienced by pilots.

5. State limitations of current and near term forecasting and observing systems for detecting and forecasting fog and low clouds.

6. * Describe orographic effects related to cloud formation.

15. Miscellaneous Weather Phenomena

1. Describe the ITCZ, easterly wave, shear line and polar trough as they affect tropical weather.

16. Weather Information

1. * Obtain, Decode, Integrate, Know Limitations of: Station model, Surface Analysis, Surface Prognostic Chart, Radar Summary Charts, Weather Depiction Charts, RAREPS, Severe Weather Watch Bulletins, Area Forecasts, In-Flight Weather Advisories, Pilot Reports, CWA, Wind-Aloft Prognostic Charts, Constant-Pressure Charts, Winds-Aloft Forecasts, Aviation Weather Reports, and Terminal Forecasts.

2. State the letter identifiers used with pilot weather reports.

3. * Read and identify data displayed in pilot weather reports and understand how to give one and why they are critical to forecasters, pilots, and controllers.

4. * Describe severe weather WATCH and WARNING issued by NWS. Describe weather ADVISORY and WARNING issued by AWS units.

5. * Identify simple features on a satellite picture and understand limitations.

6. * Understand basic sources of meteorological observations and their limitations (transmissometers, Rawinsonde, LLWAS etc.)
7. Identify seasonal and climatic weather patterns associated AWAS with ASAS various regions of the world (international operations only).
8. * Understand fundamental observation techniques and equipment, specialized equipment (low-level wind shear alert systems, etc.) and radars (weather versus air traffic control), and their relative strengths, weaknesses and capabilities. Describe the various radar equipment (airborne, ground weather, ground air traffic control), their characteristics (wave length, range, doppler, etc.), their strengths and weaknesses (attenuation, false echoes, etc.) and radar reports (echo intensity, coverage, tops, movement, etc.). Understand dial-up radar.
9. Be familiar with basic synoptic trends in chart information.
10. Be familiar with METARS and use.

17. Flight Weather Briefing (Military Only)

1. List the three sections of the DD-175-1 which provide space for specific information concerning the three phases of any flight.
2. State the requirements for completing the takeoff data section of the DD 175-1.
3. State the first weather source you should check when flight planning including the source of supplemental weather information.
4. State the teletype/facsimile sources for information on the minimum ceiling, cloud tops, thunderstorm, turbulence, icing and the minimum freezing level, precipitation, wind aloft and temperature.

18. Flight Weather Briefing (Civilian)

1. State Federal Aviation Regulation (FAR) requirements for preflight briefing.
2. Understand responsibilities of pilots and dispatchers in determining route, destination and alternate selections based upon weather.
3. State the primary consideration in selection of a flight level.
4. Know primary and alternate sources of preflight and enroute update weather including FSS, HIWAS, CWSU, etc.

CONFERENCE REVISED METEOROLOGY OBJECTIVES
* - CRITICAL INFORMATION

BUCHANAN

5.2 (ADD) Asterisk

6.5 (ADD) Asterisk

CARNEY

2.7 Define density altitude, state its parameters and its effect on aircraft performance including the differences in effect of density altitude on reciprocating, turboprop and turbojet aircraft.

3.3 Differentiate between sea level pressure, station pressure, and altimeter setting and understand the manner in which each is measured.

4.4 Describe the jet streams, their relation to weather systems, and their seasonal migration/strength/altitude. Understand the mechanisms responsible for jet streams (polar front, subtropical, polar night, where they are found, their influence on synoptic scale weather, and relationship to CAT.

6.3 Under the effect of wather vapor on stability.

6. (ADD) Be able to use at least one type of thermodynamic diagram in assessing atmospheric stability.

6. (ADD) Be familiar with the stability chart and the use of the Lifted index and the K-index.

7. (ADD TO TITLE) and Fronts

7.8 State the conditions associated with a warm front including vertical and horizontal structure.

8.4 Describe the various types of thunderstorm classifications including imbedded thunderstorms including severe, steady state, squal-line thunderstorms and mesoscale convective complexes (MCC).

8.5 Explain how radar works and how it can aid a pilot in thunderstorm flight techniques. Explain the limitations of radar, explain use of the stormscope in detecting severe weather.

8.6 (MOVE UNDER 8.9)

8.7 (MOVE UNDER 8.10)

8.10 Explain the difference between microbursts, downdrafts/updrafts, and downbursts, and their influence on aircraft.

9.1 Describe natural lighting, triggered lightning and static discharge, and the environmental conditions and flight profiles most conducive to these hazards.

10. (ADD) Understand the optical illusions associated with low-visibility operations, particularly at night or in precipitation.

11.7 Understand mechanisms which create CAT and how to minimize CAT encounters.

11.8 Understand the use of current and near term forecasting and observing systems for detecting and warning about turbulence.

11.9 Describe the relationship of the tropopause and clear air turbulence.

12.1 Know situations that create LLWS (inversion, land sea breeze).

13.4 Be able to identify icing type, intensity, and cloud types for reporting.

13.6 State the environmental conditions most conducive to carburetor induction icing on piston engines, and how it may cause engine power loss of failure. State the environmental conditions most conducive to the formation of ground induction icing for turbine engines. Describe how ground induction icing may cause turbine engines foreign object damage.

13.8 Identify icing peculiar to various types of clouds and precipitation and runway conditions.

13.9 Identify types and intensities of icing found relative to extra-tropical cyclones and fronts.

13.12 Understand icing and deicing equipment use and what FAR requires with "known icing" certification.

13.13 Know meteorological indications that tell the pilot how to avoid and leave icing.

16.1 Obtain, Decode, Integrate, Know Limitations of: Station model, Surface Analysis, Surface Prognostic Chart, Radar Summary Charts, Weather Depiction Charts, RAREPS, Severe Weather Watch Bulletins, Area Forecasts, In-flight Weather Advisories, Pilot Reports, Center Weather Advisories Winds-Aloft Prognostic Charts, Constant-Pressure Charts, Winds-Aloft Forecasts, Aviation Weather Reports, and Terminal Forecasts.

16.7

18.4 (ADD) Understand the methods of collecting and interpreting weather information from commercial weather databases.

EICK

1.3 (DELETE) Asterisk

1.4 (DELETE) Asterisk

2.2 Describe differential heating and its effect on weather (e.g. differential heating of land/water and thermal turbulence).

2.3 State and define the methods of heat transfer and relate it to convection, turbulence, etc. (Conduction, convection, radiation). Methods of cooling also important with moisture and cloud formation.

2.6 State and define the terms used to describe various non-standard lapse rates relative to the standard lapse rate and deviations from standard. (Isothermal later, inversions).

3. (ADD TO TITLE) and Altimetry

4.1 Explain global circulation and how it combines with Coriolis Parameter to produce latitudinal pressure systems and prevailing wind flows.

4.3 (ADD) Asterisk

4.4 Describe the jet streams, their relations to weather systems, and their seasonal migration strength/altitude. Understand what's responsible for jet stream (polar front, subtropical, polar night), where it's found, it's influence on synoptic scale weather, and relationship to CAT, and basic flight planning.

6. (ADD UNDER 6.1) Describe factors that can stabilize or destabilize an air mass.

6.4 State the basic types of lifting (orographic, convective, frontal, convergence, etc.)

6.5 (ADD) Asterisk

6. (ADD UNDER 6.5) Does the pilot need to know these specifics, or is application and use of stability indices more important? Understand and apply the use of the Lifting/K-Index, etc...

7. (ADD TO TITLE) and Fronts

7.1 (DELETE) Asterisk. Class if system is it directly useful to the pilot? Terminology important: MT, CP, etc..., Principle

7.2 (DELETE) Asterisk

7.3 (DELETE) Asterisk

7. (ADD UNDER 7.5) Define and describe a trough (TROF) and ridge.

7.6 State the conditions associated with a squall line (or instability line) including its movement.

7.8 State the conditions associated with a warm front including vertical and horizontal structure.

7.9 State the conditions associated with an occluded fronts including vertical and horizontal structure of both the warm and cold front occlusions.

7. (ADD UNDER 7.12) Describe the normal development and life cycle of a frontal wave.

8.4 Describe the various types of thunderstorm classifications including air mass type, imbedded thunderstorms, steady state, severe super cells and squall-line type thunderstorms and Mesoscale Convective Complexes (MCC).

8. (CREATE UNDER 8.11) Windshear Section Convective and Nonconvective

8.7 (MOVE UNDER) Windshear Section

8.8 State limits of current terminal forecast systems for detecting and warning of thunderstorm hazards. Should be covered under the product section.

8.9 Describe the various hazards that are associated with most thunderstorms, and the distances from the storms where these hazards can be encountered (hail, heavy rain, windshear, gust fronts, lightning, tornadoes, strong winds).

8.10 (MOVE UNDER) Windshear Section

9.1 (DELETE) Asterisk

9.2 (DELETE) Asterisk. Explain how pilots can minimize exposure to lightning and discharge conditions. Note - old rule of thumbs are out-of-date and have been proven to be incorrect!

9.3 (DELETE) Asterisk

10.1 (DELETE) Asterisk

11.5 Describe the method by which wake turbulence forms, and its operational problems on take-offs and landings.

11.6 State the terms and definitions used to describe the four intensities of turbulence and their frequency. Describe the difference between turbulence and chop, and define clear air turbulence (CAT).

11.7 Understand the mechanism that creates CAT and how to minimize a CAT encounter.

12.1 Know situations that create LLWS (inversion, low-level jet streams, frontal systems and land-sea breezes.

13.5 (ADD) Asterisk

13.6 (DELETE) Asterisk

13.9 Identify types and intensities of icing found relative to low pressure systems and fronts.

13.10 State the flight techniques for avoiding icing when encountering wet snow, ice pellets, or freezing rain.

13.11 (DELETE) Asterisk

14.3 Define an inversion, its causes, and effects on low vis events.

14.5 (ADD) Asterisk

15. (ADD ABOVE 15.1) Tropical weather discussion as required.

15. (ADD BELOW 15.1) Hurricanes, Typhoons, etc...

16.1 Obtain, Decode, Integrate, Know Limitations of: Station model, Surface Analysis, Surface Prognostic Chart, Radar Summary Charts, Weather Depiction Charts, RAREPS, Severe Weather Watch Bulletins, Area Forecasts, In-Flight Weather Advisories, Pilot Reports, CWA, Wind-Aloft Prognostic Charts, Constant-Pressure Charts, Winds-Aloft Forecasts, Aviation Weather Reports, Terminal Forecasts and Stability Charts.

16.2 State the letter identifiers used with pilot weather reports and forecasts.

16.5 (DELETE) Asterisk

16.10 Be familiar with METARS, TAFORS and their use. (International)

FRANCHI

2.6 (DELETE) Asterisk

5.4 (DELETE) Asterisk

6.4 (DELETE) Asterisk

7.1 (DELETE) Asterisk

7.2 (DELETE) Asterisk

7.3 (DELETE) Asterisk

7.4 (DELETE) Asterisk

HEY

1.3 (DELETE) Asterisk

2.4 (DELETE) Asterisk

2.5 (DELETE) Asterisk

2.8 (DELETE) Asterisk

2.9 (DELETE) Asterisk

3.8 (DELETE) Asterisk

4.3 Explain the principles for identifying geostrophic, gradient, and

friction layer winds, with respect to isobars around high and low pressure systems in the both hemispheres.

5.3 comprehend the various moisture terms and their relationship to each other in the formation of clouds, fog, dew, frost and precipitation.

6.1 (DELETE) Asterisk

6.2 (DELETE) Asterisk

8.5 Explain how radar works and how it can aid a pilot in thunderstorm avoidance. Explain the limitations of radar including attenuation, explain [storm-scope?]

8.7 Describe winshear and microburst recognition and avoidance, and pilot techniques for escape.

8.11 Describe how to circumnavigate thunderstorms using in-flight visual cues.

15.1 (DELETE) All

MARTIN

2.2 (DELETE) All

2.3 (DELETE) All

2.4 (DELETE) All

2.6 (DELETE) All

2.8 (DELETE) All

3.4 (DELETE) All

3.5 Describe the effects of temperature and pressure on altimetry.

4.3 (DELETE) All

5.1 (DELETE) All

6.2 (DELETE) All

6.5 (DELETE) All

7.2 (DELETE) All

8.5 Explain how radar can aid a pilot in thunderstorm flight techniques. Explain the limitations of radar, explain storm-scope in detecting severe weather.

10.1 (DELETE) All

11.8 (DELETE) All

11.9 (DELETE) All

13.6 State the environmental conditions most conducive to the formation of ground induction icing for jet engines. Describe how ground induction icing may cause jet engines foreign object damage.

13.11 (DELETE) All

14.5 (DELETE) All

14.5 (DELETE) All

15.1 (DELETE) All

16.8 Understand fundamental observation techniques and equipment, specialized equipment (low-level wind shear alert systems, etc.) and radars (weather versus air traffic control), and their relative strengths, weaknesses and capabilities.

16.9 (DELETE) All

MASSEY

3.6 (COMBINED) Together with 3.7

8.4 Describe the various types of thunderstorm classifications including imbedded, severe, steady state, squall-line thunderstorms and mesoscale convective (MCC).

8.6 State the various flight techniques that are recommended for flight near or in thunderstorms. Including the use of infor visual cues.

8.9 (DELETE) All

8.11 (DELETE) All

16.6 (DELETE) All

PEARSON

1.3 State the five elements of weather that a pilot may encounter in flight-temperature, pressure, wind, humidity, clouds, precipitation.

2.7 (COMBINED) Together with 2.9

3.6 (COMBINED) Together with 3.7

4. (CREATE UNDER 4.4) Add tropical winds patterns here (See miscellaneous weather phenomena)

8.10 Explain the difference between microbursts, downdrafts/updrafts, and downburst, and their influence on aircraft.

13.1 (COMBINED) Together with 13.8 and 13.9

13.3 (COMBINED) Together with 13.7

15. and 15.1 (Rather than one separate item here combine this in winds and circulation)

16.1 Obtain, Decode, Integrate, Know Limitations of: Station model, Surface Analysis, Surface Prognostic Chart, Radar Summary Charts, Weather Depiction Charts, RAREPS, Severe Weather Watch Bulletins, Area Forecasts, In-flight Weather Advisories, CWA, Wind-Aloft Prognostic Charts, Constant-Pressure Charts, Winds-Aloft Forecasts, Aviation Weather Reports, and Terminal Forecasts.

POELLOT

1.3 State the eight elements of weather that a pilot may encounter in flight--temperature, pressure, wind, humidity, clouds, precipitation, aerosol, visibility.

4.3 (ADD) Asterisk

8.4 Describe the various types of thunderstorm classifications including imbedded thunderstorms including severe, steady state, squall-line thunderstorms and mesoscale convective complex (MCC).

12.1 Know situations that create LLWS (inversion, land, sea breeze, front).

16.1 Obtain, Decode, Interpret, Integrate, Know Limitations of: Station model, Surface Analysis, Surface Prognostic Chart, Radar Summary Charts, Weather Depiction Charts, RAREPS, Severe Weather Watch Bulletins, Area Forecasts, In-Flight Weather Advisories, Pilot Reports CWA, Wind-Aloft Prognostic Charts, Constant-Pressure Charts, Winds-Aloft Forecasts, Aviation Weather Reports, and Terminal Forecasts. Low-and High-level Sig weather progs.

16.10 Be familiar with METARS, TAFs and AIREPs and use.

18. (CREATE UNDER 18.4) 19. Human Factors

19.1 Decision-making and judgement as related to weather.

VOGT

12.1 Know situations that create LLWS (inversion, land sea breeze and fronts), and their influence on aircraft landing and takeoff.

13.4 Be able to identify icing type, intensity, and clouds for reporting. Understand the definitions/terms used in forecasts for icing type and intensity.

13.7 Explain the effects of ice, snow and frost on aircraft surfaces on takeoff performance, and the proper procedures and effectiveness of ground de-icing.

16.10 (DELETE) ALL

17.3 State the first weather source you should check when flight planning, including the source of supplemental weather information.

18.4 (MOVE UNDER 17.4)

RECOMMENDATIONS OF THE WORKING GROUPS

Recommendations of the Military Working Group

- Increase the amount of meteorology training in the Air Force Undergraduate Pilot Training program. The Air Force uses only one-half of the amount of training time for meteorology than any of the other military training programs. This raised the concerns of many of the attendees. The sixteen hours should be increased to about 22-25 hours.
- Have UPT meteorology taught by a meteorologist. The Air Force seems dedicated to the pilot-meteorologist team concept. If this is a firm policy then it is appropriate for that team concept to begin from the very beginning.
- Air Force continuation training in weather needs to be increased. This is especially important with the increase and changes in technology now taking place in the Air Weather Service and for pilot briefing strategy.
- Meteorology continuation training must be APPLIED to flying, not just theory.

- The military must gain access to videotape training products now being developed by the civilian research community including the National Center for Atmospheric Research.
- Pilot evaluations must include an evaluation of weather knowledge.
- The AF Annual Instrument Refresher Course must be STANDARDIZED and INSTITUTIONALIZED so that all pilots have access to information that is available. This is important because few pilots are meteorologists and few AWS personnel are pilots, so there is little ability at the base level to know what needs refreshing.
- The military training programs should compare meteorology training and share information to understand the disparity in training time spent on weather.
- The military working group should meet again in Fall 1989.

Recommendations of civilian working group

- There is a need to organize an on-going effort to examine meteorology training for civilian pilots.
- There is a fundamental difference between the civilian and military environments that require a different approach to pilot meteorology training. Civilians lack the access to meteorologists and to recurrent training in weather.
- There must be follow-on training for the professional pilot in light of the new technologies that exist in the aviation weather system.
- There must be a review of accident statistics to validate the need to increase pilot meteorology training.
- The current lack of training for pilots is an economic and legislative problem. Regulations must mandate the training for it to occur.
- The flight review process for all pilots should include an examination of the pilot's level of weather knowledge.

SUMMARY OF THE PROFESSIONAL PILOTS' METEOROLOGY TRAINING
STANDARDS CONFERENCE

The Professional Pilots' Meteorology Training Standards Conference met April 13-14, 1989 at the United States Air Force Academy. The 31 participants had two goals. The first objective was to develop a list of specific training objectives for all professional pilots (commercial-instrument rating or a graduate of a military training program) in meteorology. The second goal was to develop a dialogue between pilots and meteorologists about the needs and expectations of both groups in the aviation weather system. The conference completed both goals. Two working groups, a military and a civilian oriented group, formed and are now carrying on the work of implementing changes recommended at the conference.

Weather 01—2 Hours
(CAI Lesson AF0302)

THE ATMOSPHERE

OBJECTIVES:

1. Given a characteristic of one of the lower layers of the atmosphere, determine if it pertains to the:
 - a. Troposphere.
 - b. Tropopause.
 - c. Stratosphere.
2. Explain the relationship between the distribution of atmospheric temperature and:
 - a. Latitude.
 - b. Atmospheric and ocean currents.
 - c. Altitude.
3. Explain the relationship between the distribution of water vapor in the atmosphere and:
 - a. Temperature.
 - b. Terrain.
 - c. Altitude.
4. Given a statement describing a change in either atmospheric moisture content and (or) temperature, determine if the relative humidity and (or) temperature-dewpoint spread will increase or decrease.
5. Identify those statements which describe:
 - a. Evaporation.
 - b. Condensation.
 - c. Sublimation.
 - d. Melting.
 - e. Freezing.
6. Identify the characteristics of a stable atmosphere and an unstable atmosphere.

Weather 02—2 Hours
(CAI Lessons AF0303/04)

FOG AND CLOUDS

OBJECTIVES:

1. Given a statement describing the processes that forms fog, determine if the fog is:
 - a. Steam fog.
 - b. Frontal fog.
 - c. Radiation fog.
 - d. Advection fog.
 - e. Upslope fog.
2. Given a statement describing a reported visibility, determine if the visibility is:
 - a. Slant Range.
 - b. Runway Visual Range (RVR).
 - c. Prevailing Visibility.
3. Given a statement describing one of six different cloud types, determine if the cloud is:
 - a. Cumulus.
 - b. Cumulonimbus.
 - c. Stratus.
 - d. Nimbostratus.
 - e. Stratocumulus.
 - f. Cirrus.
4. Given a statement describing the characteristics, types, intensities, and hazards of icing, determine if the icing is:
 - a. Rime.
 - b. Clear.
 - c. Mixed.
 - d. Frost.
5. Identify the procedures used to avoid and (or) minimize the effects of icing while flight planning or en route.

Weather 03—2 Hours
(CAI Lessons AF0305/06)

PRESSURE DISTRIBUTION

OBJECTIVES:

1. Identify how changes in either the temperature or moisture content of the air will cause the surface pressure to change.
2. Given a statement describing the horizontal distribution of pressure, determine what effect this distribution will have on the horizontal movement of air.
3. Describe the general wind flow pattern, types of clouds, and changes in visibility often associated with areas of high pressure.
4. Given a description of weather often associated with a particular type of air mass, determine if the air mass is:
 - a. Continental Polar.
 - b. Maritime Polar.
 - c. Continental Tropical.
 - d. Maritime Tropical.
5. Given the description of weather often associated with various frontal systems, determine if the front is a:
 - a. Cold front.
 - b. Warm front.
 - c. Stationary front.
 - d. Occluded front.
6. Identify the characteristics of low pressure systems.

Weather 04—1 Hour
(CAI Lesson AF0307)

TURBULENCE AND WIND SHEAR

OBJECTIVES:

1. Given a statement describing how atmospheric turbulence is formed, determine if the turbulence is:
 - a. Convective.
 - b. Mechanical.
 - c. Mountain Wave.
 - d. Clear Air Turbulence (CAT).
2. Identify the procedures used to avoid and (or) minimize the effects of turbulence.
3. Identify those conditions in which wind shear develops, the hazards associated with wind shear, and the best way to minimize those hazards.

Weather 05—2 Hours
(CAI Lessons AF0308/09)

THUNDERSTORMS

OBJECTIVES:

1. Define the three prerequisites for thunderstorm development.
2. Given a statement describing the stages in the life cycle of a thunderstorm, determine if the storm is in the:
 - a. Cumulus stage.
 - b. Mature stage.
 - c. Dissipating stage.
3. Describe how microbursts are formed, the associated hazards, and ways to minimize their effects.
4. Describe the various methods and procedures used to avoid and (or) minimize the effects of thunderstorm activity.

**Weather 06-7 Hours
(AX 0802/03)**

BASIC WEATHER SERVICES

OBJECTIVES:

1. Identify the type of information a pilot will need to obtain from the forecaster in order to obtain a complete weather briefing.
2. Given a location on a Surface Analysis chart, identify:
 - a. Squall lines.
 - b. Types of fronts.
 - c. Pressure centers.
 - d. The general direction of the surface wind flow pattern.
3. Given a location on a Weather Depiction chart, identify areas of IFR, MVFR, and VFR weather.
4. Given a location of a radar echo on a Radar Summary chart, identify the following:
 - a. Type of echo
 - b. Type of weather occurring
 - c. Movement of the echo pattern
 - d. Intensity of the echo
 - e. Height of the echo
5. Given a GOES satellite picture identify:
 - a. Low pressure areas and associated fronts.
 - b. Areas of strong winds.
 - c. Areas of mountain wave turbulence.
 - d. Areas of fog.
6. Given a specific location on a CAT/ICING Forecast chart, identify the following:
 - a. Types of weather forecasted
 - b. Intensity
 - c. Height levels
7. Given an area on a Military Weather Advisory (MWA) chart, identify the following:
 - a. Type of weather forecasted
 - b. Conditions
 - c. Valid times
8. Given a Surface Prognostic chart, identify weather conditions expected for a specific location.
9. Given a Winds Aloft chart, calculate the cruise winds and temperatures from one specific location to another.
10. Given a completed DD form 175-1, interpret the weather information presented on the form.

METEOROLOGY THEORY WORKBOOK I
ENABLING OBJECTIVES

<u>Obj #</u>	<u>Objective</u>	<u>PRI NASC</u>	<u>PRI MOD 1</u>	<u>PRI MOD 5</u>
General Structure of the Atmosphere				
1.1	Describe the two lower layers of the atmosphere.	x		
1.2	State the composition of the atmosphere.	x		
1.3	State the condition that results in hypoxia and the suggested rule to avoid it.	x	x	x
1.4	State the six elements of weather that a pilot may encounter in flight.	x	x	
1.5	State the five primary hazards to flight.	x	x	
Atmospheric Temperature				
A2-2.1	State and define the primary source of all weather.	x		
2.2	Define specific heat and explain how it affects the warming of the earth's surface.	x		
2.3	State and define the methods of heat transfer.	x		
2.4	Convert temperature from Fahrenheit to Celsius and vice-versa.			OMIT FROM COURSE
2.5	State the standard lapse rate in Celsius and Fahrenheit.		Celsius only	x x
2.6	State and define the terms used to describe various non-standard lapse rates relative to the standard lapse rate.		OMIT BUT LEAVE TEXT IN BOOK	
2.7	Define density altitude, state its parameters and its effect on aircraft performance.	x	x	

Atmospheric Pressure

3.1 Define the term atmospheric pressure.

3.2 State the standards and the lapse rates used with atmospheric pressure.

3.3 Differentiate between sea level pressure and station pressure.

3.4 State the types of equipment used in measuring atmospheric pressure.
A2-2 OMIT BUT LEAVE TEXT IN BOOK

3.5 State and describe selected terms used on pressure maps with which a pilot should be familiar.

3.6 Describe the effects of pressure on altimetry and solve selected altimeter problems.

3.7 State and define the different measures of altitudes with which a pilot should be familiar.

Winds and Their Circulation

4.1 Define and explain concepts of the various forces and terms used to discuss winds and their circulation.
A2-2 OMIT BUT LEAVE TEXT IN BOOK

4.2 State Buys Ballot's Law and its application to flight.

4.3 Explain the tri-cell theory and how it combines with the Coriolis Force to produce latitudinal pressure systems and prevailing wind flows.

4.4 Describe selected small scale wind circulations and how they could affect flight.

4.5 Demonstrate comprehension of the principles for identifying gradient and surface winds, with respect to isobars around high and low pressure systems in the Northern Hemisphere.

Obj #	Objective	NASC	PRT	PRT	PRT	MOD 1	MOD 5
	<u>Turbulence</u>						
5.1	Given a state of the atmosphere, describe the transfer of latent heat during a change from one state to another.	x					
5.2	State the conditions that may produce dew or frost on an aircraft.	x	x				
5.3	Display a comprehension of the various moisture terms and their relationship to each other in the formation of clouds, fog, dew, frost and precipitation.	x	x				
5.4	Given examples of clouds, identify them as to form, flight characteristics, precipitation and classification.	x	x				
	<u>Atmospheric Stability</u>						
6.1	Define the terms stability/instability as they apply to the atmosphere.	x					
A2-6.2	Define adiabatic processes and state the terms used to describe lapse rates, including the values of the dry, moist and average in both Celsius and Fahrenheit.	x	x				
6.3	State the four basic types of lifting.	x					
6.4	Describe the conditions that must exist for conditional or convective instability.	x					
6.5	Identify cloud types with their associated stability.	x	x				
	<u>Air Masses</u>						
7.1	Define an air mass	x					
7.2	Describe the air mass classification system including moisture content and temperature.	x					
7.3	State the relationship between air mass temperature and stability.	x					
7.4	State the basic flight conditions in selected air masses.	x	x				

Obj. # Objectives

PRI	PRI
NASC	MOD 1
MOD 5	

Frontal Systems

8.1 State the meaning of the terms frontogenesis and frontolysis.

8.2 Describe the frontal discontinuities used to locate and classify fronts.

8.3 State the factors that influence frontal weather.

8.4 State the conditions associated with a cold front.

8.5 State the conditions associated with a squall line.

8.6 State the conditions associated with a warm front.

8.7 State the conditions associated with an occluded front.

A2-8.8 State the conditions associated with a stationary front.

8.9 State the color and symbol codes by which a pilot can identify a front on a locally prepared surface chart.

Thunderstorms

9.1 State the requirements for thunderstorm formation.

9.2 Describe the thunderstorm life cycle and the characteristics of each stage.

9.3 Describe the various hazards that are associated with most thunderstorms.

9.4 Describe the various types of thunderstorm classifications.

9.5 Explain how radar can aid a pilot in thunderstorm flight techniques.

9.6 State the various flight techniques that are recommended for flight near or in thunderstorms.

9.7 ADD ADDITIONAL OBJECTIVES/TEXT ON WINDSHEAR/MICROBURST RECOGNITION/
AVOIDANCE AND PILOT TECHNIQUES FOR ESCAPE. 4

OMIT BUT LEAVE
TEXT IN BOOK

Obj #	Objective	NASC	PRI	NASC	PRI	NASC	PRI
		MOD_1	MOD_5	MOD_1	MOD_5	MOD_1	MOD_5
Turbulence							
10.1	Describe the method by which thermals create turbulence.	x	x				
10.2	Describe the method by which terrain creates mechanical turbulence.	x	x				
10.3	Describe the method by which frontal lifting creates turbulence.	x	x				
10.4	Describe the method by which large scale wind shear creates turbulence.	x	x				
10.5	Describe the method by which turbulence forms and its effects on take-offs and landings.	x	x				
10.6	State the terms used to describe the four intensities of turbulence and their frequency.	x	x				
Icing							
A2-5	11.1 State the requirements for the formation of structural icing.	x	x				
	11.2 State the temperature range most conducive to icing.	x	x				
	11.3 State the factors affecting the accumulation of ice on aircraft.	x	x				
	11.4 State the cumulative effects of icing on an aircraft.	x	x				
	11.5 Describe the most common types of frozen moisture and their effects on aircraft.	x	x				
	11.6 State how induction icing may cause engine failure.	x	x				
	11.7 State the effects of icing on propellers and pitot systems.	x	x				

Obj # Objective

11.8 Identify icing peculiar to various types of clouds and precipitation. x x x x

11.9 State the flight techniques for avoiding icing when encountering wet snow or freezing rain.

Fog and Low Clouds

12.1 Define fog and low clouds. x

12.2 State the three general conditions required for condensation. x

12.3 State the two methods of reaching saturation. x

12.4 State how winds aid in the formation or dissipation of fog and low ceiling clouds. x

A12.5 State the two basic classifications of fog. x

12-6 12.6 State conditions required for the formation or dissipation of the various types of fog. COMBINE WITH 12.4

12.7 Define the terms: obscuration, partial obscuration and vertical visibility. x x

Miscellaneous Weather Phenomena

13.1 Describe the ITCZ, easterly wave, shear line and polar trough as they affect tropical weather.

13.2 State the wind parameters for the various stages of hurricane formation.

13.3 State the latitudes and type of surface most conducive for hurricane formation.

13.4 State the destructive forces associated with hurricanes.

13.5 Describe the types of tornadic activity.

13.6 State the method by which tornadoes cause damage.

Obj #	Objective	PRI NASC	MOD 1	PRT MOD 5
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13.7 Describe the various weather warnings.

CANCEL MOD 13.0 BUT RETAIN F. O. 13.7 FOR LATER INCLUSION IN ROOK 2.

METEOROLOGY FLIGHT PLANNING WORKBOOK II
ENABLING OBJECTIVES

Obj #	Objective		PRI	PRI	NASC	MOD 1	MOD 5
Station Models, Surface Analysis & Surface Prognostic Charts							
1.1	State the building blocks of surface weather charts.		x				
1.2	Identify plotted wind conditions.		x				
1.3	Identify plotted weather and visibility.		x				
1.4	Identify plotted pressures and temperatures.		x				
1.5	Identify plotted cloud types.		x				
1.6	Identify plotted sky cover.		x				
1.7	Determine whether plotted data is forecast or observed.		x				
1.8	State the purpose for which a pilot uses a surface analysis chart.		x				
1.9	Identify data displayed on surface analysis charts.		x				
1.10	State the purpose for which a pilot uses a surface prognostic chart.		x				
1.11	Identify data displayed on surface prognostic charts.		x				
Radar Summary Charts and Weather Depiction Charts							
2.1	Determine whether plotted data is observed or forecast.		x				
2.2	Identify plotted radar echoes and intensities on radar summary charts.		x				
2.3	Identify weather contractions and their accompanying trend symbols on radar summary charts.		x				
2.4	Identify echo movements including echo tops and bases on radar summary charts.		x				
2.5	Identify indicated severe weather areas on radar summary charts.		x				

Obj #	Objective	NASC	PRI	MOD 1	PRT MOD 5
2.6	Identify two-letter codes used in lieu of radar reports on radar summary charts.		x		
2.7	Identify sky coverage symbols plotted on a weather depiction chart and weather symbols.		x		
2.8	State the definition of a ceiling and how heights are reported.		x		
2.9	Identify data plotted around the sky cover symbol and the rules of omission on a weather depiction chart.		x		
2.10	State the criteria and methods for plotting areas of IFR/MVFR/VFR on a weather depiction chart.		x		
	<u>Severe Weather Watch Bulletins and Area Forecasts</u>				
3.1	State the severe weather watch's two-letter teletype identifier.		x		
3.2	State the requirements for issuing a severe weather watch.		x	x	
3.3	State the severe weather watch's relationship to OPNAVINST 3710.7 and flight planning.		x		
3.4	Read and identify data on a severe weather watch message.		x		
3.5	State the area forecast's two-letter identifier.		x		
3.6	Identify valid periods of forecast and outlook.		x		
3.7	State the rules of MSI/AGL as they pertain to an area forecast.		x		
3.8	Read and identify displayed data in an area forecast message.		x		
3.9	State the wind and visibility rules that apply to an area forecast.		x		
3.10	ADD SEVERE WEATHER WARNING, WINDSHEAR, MICROBURST OBJECTIVES FROM BOOK I AND TEACH IN ADVANCED				

Obj #	Objective	PRI NASC	PRI MOD 1	PRI MOD 5
In-Flight Weather Advisories and Pilot Reports				
4.1	State the use of in-flight weather advisories.	x		
4.2	State the teletype letter identifiers used with in-flight weather advisories.	x		
4.3	State the criteria used for issuing each of the in-flight weather advisories.	x		
4.4	Read and identify data displayed in the in-flight weather advisories.	x		
4.5	State the letter identifiers used with pilot weather reports.	x		
4.6	Read and identify data displayed in pilot weather reports.	x		
Winds-Aloft Prognostic Charts, Constant-Pressure Charts and Winds-Aloft Forecasts				
5.1	State the use of winds-aloft prognostic charts.	x		
5.2	State the meaning of valid time on winds-aloft prognostic charts.	x		
5.3	Identify plotted data on a winds-aloft prognostic chart.	x		
5.4	State the use of a constant-pressure chart.		DELETE FROM COURSE AND TEXT	
5.5	State the three lowest levels of constant-pressure charts in millibars and their height in feet.		DELETE FROM COURSE AND TEXT	
5.6	State the names of the three types of lines drawn on a constant-pressure chart.		DELETE FROM COURSE AND TEXT	
5.7	Identify data plotted on a constant-pressure chart including the rules for shading in a station model.		DELETE FROM COURSE AND TEXT	
5.8	State the teletype identifier for a winds-aloft chart.	x		
5.9	Identify coded data in a winds-aloft forecast.	x		

Obj #	Objective	NASC	PRT	PRI
		MOD 1	MOD 1	MOD 5
5.10	State rules for omission of temperature and winds in a winds-aloft forecast.		x	
5.11	Select a flight altitude from a winds-aloft forecast that results in the most favorable wind component.		x	
6.1	State the letter identifiers used to report various types of aviation weather reports.		x	
6.2	State the use of aviation weather reports in flight planning.		x	
6.3	Identify the cloud data in aviation weather reports.		x	
6.4	Identify the visibility data in aviation weather reports.		x	
6.5	Identify the weather and obstructions to vision data in weather reports.		x	
6.6	Identify the pressure/altimeter data in aviation weather reports.		x	
6.7	Identify the temperature/dew point data in aviation weather reports.		x	
6.8	Identify the wind data in aviation weather reports.		x	
6.9	Identify the remarks data in aviation weather reports.		x	
7.1	State the use of terminal forecasts in flight planning.		x	
7.2	State the two-letter teletype identifier used to identify terminal forecasts.		x	
7.3	Identify data in the terminal aerodrome forecast (TAF) code.		x	
7.4	Identify data in a U. S. civilian terminal forecast.		x	

Obj #	Objective	PRI NASC	PRI MOD 1	PRI MOD 5
7.5	State the IFR/VFR rules for flight planning.	x		
7.6	State the rules for requirement of an alternate on an IFR flight plan.	x		
	Flight Weather Briefing			
8.1	List the three sections of the DD-175-1 which provide space for specific information concerning the three phases of any flight.	x		
8.2	State the requirements for completing the takeoff data section of the DD 175-1.	x		
8.3	State the first weather source you should check when flight planning including the source of supplemental weather information.	x		
8.4	State the teletype/facsimile sources for information on the minimum ceiling en route.	x		
8.5	State the teletype/facsimile sources for information on the maximum cloud tops.	x		
8.6	State the teletype/facsimile sources for information on thunderstorm activity en route .	x		
8.7	State the teletype/facsimile sources for information on turbulence en route .	x		
8.8	State the teletype/facsimile sources for information on icing and the minimum freezing level.	x		
8.9	State the teletype/facsimile sources for information on precipitation en route .	x		
8.10	State the teletype/facsimile sources for wind aloft and temperature information en route .	x		
8.11	State the primary consideration in selection of a flight level.	x		
8.12	Determine if an alternate is required and state the source used to select the best possible alternate.	x		

Obj #	Objective	PRI	PRT	NASC	MCR	1	MOD	5
8.13	State with whom the ultimate responsibility for the weather briefing prior to each flight belongs.					x		
8.14	State the use and composition of a flight forecast folder and the minimum time allowed to request one.							

COMPLETE LIST OF SUGGESTED
METEOROLOGY
OBJECTIVES

General Structure of the Atmosphere

Describe the two lower layers of the atmosphere and their boundary.

State the composition of the atmosphere.

State the condition that results in hypoxia and how to avoid it.

State the six elements of weather that a pilot may encounter in flight--temperature, pressure, wind, humidity, clouds, precipitation. (aerosol)

State the primary hazards to flight. (turbulence low, level wind shear, hail, icing, low ceiling, low visibility, thunderstorm, lightning).

Atmospheric Temperature

State and define the primary source of all weather. (insolation)

Define specific heat and explain how it affects the warming of the earth's surface. (e.g. differential heating of land/water and thermal turbulence).

State and define the methods of heat transfer. (relate it to convection and turbulence, etc.)

Convert temperature from Fahrenheit to Celsius and vice-versa.

Define ISA - International Standard Atmosphere.

State the standard lapse rate in Celsius and Fahrenheit.

State and define the terms used to describe various non-standard lapse rates relative to the standard lapse rate. Also deviation from standard.

Define density altitude, state its parameters and its effect on aircraft performance. (Differential density altitude on recip & jets - Understand effect of water vapor on density altitude)

Explain the importance of the adiabatic lapse rate.

Know how to compute density altitude and how it is affected by pressure, temperature, and humidity changes.

Describe the hazards unique to aircraft ground operations in extremely cold temperatures.

Atmospheric Pressure

Define the term atmospheric pressure.

State the standards and the lapse rates used with atmospheric pressure.

Differentiate between sea level pressure, and station pressure, (and altimeter setting and understand the manner each measured)

State the types of equipment used in measuring atmospheric pressure. (and their limits and accuracy)

Understand the Kollsman window on the altimeter.

State and describe selected terms used on pressure maps with which a pilot should be familiar.

Describe the effects of temperature and pressure on altimetry and solve selected altimeter problems.

State and define the different measures of altitudes with which a pilot should be familiar.

Define pressure altitude, state its parameters and its effect on aircraft performance.

Know how to compute pressure altitude and how it is affected by pressure changes.

Compare pressure altitude and density altitude.

Winds and Their Circulation

Define and explain concepts of the various forces and terms used to discuss winds and their circulation.

State Buys Ballot's Law and its application to flight.

Explain global circulation and how it combines with the Coriolis Force to produce latitudinal pressure systems and prevailing wind flows.

Describe selected small scale wind circulations and how they could affect flight. (cyclones, sea/land breeze, katabats, venturi effects)

Demonstrate comprehension of the principles for identifying (geostrophic), gradient, and (friction layer) winds, with respect to isobars around high and low pressure systems in the Northern Hemisphere.

Describe the jet streams, their relation to weather systems, and their seasonal migration/strength/altitude. (Understand what's responsible for jet stream (polar front, subtropical, polar night) where found, influence on synoptic scale weather, relationship to CAT)

Describe wind flow around high and low pressure systems in both the Northern and Southern Hemispheres.

MOISTURE

Given a state of the atmosphere, describe the transfer of latent heat during a change from one state to another.

State the conditions that may produce dew or frost on an aircraft.

Display a comprehension of the various moisture terms and their relationship to each other in the formation of clouds, fog, dew, frost and precipitation.

Given examples of clouds, identify them as to form, flight characteristics, precipitation and classification. (and flight hazards)

Atmospheric Stability

Define the terms stability/instability as they apply to the atmosphere.

Define adiabatic process and state the terms used to describe lapse rates, including the values of the dry, moist and average in both Celsius and Fahrenheit. (Understand effect of water vapor on stability)

State the four basic types of lifting. (Be familiar with one type of thermodynamic diagram.)

Describe the conditions that must exist for conditional or convective instability.

Identify cloud types (and flight hazards) with their associated stability. (Derive and demonstrate K index, lifted index, show walter index)

Air Masses

Define an air mass

Describe the air mass classification system including moisture content and temperature. (source region)

State the relationship between air mass temperature and stability.

State the basic flight conditions in selected air masses.

State the meaning of the terms frontogenesis and frontolysis.
(cyclogenesis and cyclolysis)

Describe the frontal discontinuities used to locate and classify fronts.

State the factors that influence frontal weather.

State the conditions associated with a cold front. (include vertical and horizontal structure)

State the conditions associated with a squall line. (include courses of squall lines)

State the conditions associated with warm front. (include vertical and horizontal structure)

State the conditions associated with an occluded front. (include vertical and horizontal structure)

State the conditions associated with a stationary front. (include vertical and horizontal structure)

State the conditions associated with a sea/land breeze front.

State the color and symbol codes by which a pilot can identify a front on a locally prepared surface chart.

Cyclogenesis and upper level divergence/lower level convergence in low pressure trough, and upper level convergence/lower level divergence/and onto cyclone ridge system.

Explain the effect of terrain on the progression of air masses.

THUNDERSTORM

State the requirements for thunderstorm formation. (include where newly developing thunderstorms are likely to form)

Describe the thunderstorm life cycle and the characteristics of each stage.(include severe, steady state squall-line thunderstorms and meso scale convective complex (MCC))

Describe the various types of thunderstorm classifications. (include imbedded thunderstorms and include severe, steady state squall-line thunderstorms and mesoscale convective complex (MCC)).

Explain how radar works and how it can aid a pilot in thunderstorm flight techniques. (Explain the limitations of radar, explain storm-scope in detecting severe weather)

State the various flight techniques that are recommended for flight near or in thunderstorms.

Explain windshear/microburst recognition and avoidance, and know pilot techniques for escape.

State limits of current terminal forecast systems for detecting and warning of thunderstorm hazards.

Describe the various hazards that are associated with most thunderstorms, and the distances from the storms where these hazards can be encountered.

Explain the difference between microbursts, downdrafts/updrafts and down burst, and their influence on aircraft.

LIGHTNING

Describe natural lightning, triggered lightning and static discharge, and the environmental conditions and flight profiles most conducive to these hazards.

Explain how pilots can minimize exposure to lightning and discharge conditions.

Explain the hazards of lightning and electrostatic discharge to aircraft operations, with emphasis on changing vulnerabilities of aircraft due to increasing use of composite materials, fly-by-wire control systems, and low-power digital electronics systems and avionics.

VISIBILITY

Describe the relative effects of various precipitation types, aerosols and fog on in-flight visibility.

Understand the difference between sector visibility, prevailing visibility, transmissometer visibility, in-flight visibility and slant-range visibility.

Describe the effect of sun position causing forward and back scatter, and how this affects visibility.

Understand the definitions of sunrise/sunset and morning/evening civil twilight, and the effects of night and twilight on visibility.

Turbulence

Describe the method by which thermals create turbulence.

Describe the method by which terrain creates mechanical turbulence. (mountain waves and indicators)

Describe the method by which frontal lifting creates turbulence.

Describe the method by which large scale wind shear creates turbulence.

Describe the method by which turbulence forms, and its effects on take-offs and landings.

State the terms and definitions used to describe the four intensities of turbulence and their frequency.

Understand mechanisms to create CAT and how to minimize CAT encounter.

State limitations of current/near term forecast/observing systems for detecting/warning on turbulence.

Understand "high speed" upset as it applies to turbo jet operations at high altitude.

Describe the relationship of the tropopause and turbulence.

Understand how various aircraft characteristics such as size, speed, wing loading, etc., dictate a given aircraft's response to turbulent conditions, and therefore require adjustment of turbulence intensity reports from pilot reports and forecasts.

Describe common pilot techniques for flight operations in turbulent conditions.

Icing

State the environmental conditions most conducive to the formation of structural icing.

State the factors affecting the accumulation of ice on aircraft.

State the cumulative effects of icing on an aircraft.

Describe the most common types of icing and frozen moisture and their effects on aircraft. (including supercooled liquids)

State how induction icing may cause engine failure. (Be able to ID icing intensities used for reporting and visibility of icing with type)

State the environmental conditions most conducive to the carburetor induction icing on piston engines, and how it may cause engine power loss or failure.

State the environmental conditions most conducive to the formation of ground induction icing for jet engines.

Describe how ground induction icing may cause jet engine foreign object damage.

Explain the operation/differences between de-icing and anti-icing systems, their proper use, and their effectiveness in various icing conditions.

Explain the effects of ice, snow and frost on aircraft surfaces on takeoff performance, and the proper procedures and effectiveness of ground de-icing.

Describe environmental conditions and aircraft operations conducive to ice formation in aircraft fuel systems.

State the terms and definitions used to describe the intensities of icing and their frequency.

Use constant pressure charts to forecast icing at cruise altitude.

Identify icing peculiar to various types of clouds and precipitation. (and runway conditions)

Identify types and intensities of icing found relative to extra trop cyclone and fronts)

State the flight techniques for avoiding icing when encountering wet snow or freezing rain.

State limitations of current/near term forecast/observing systems for detecting/forecasting icing. (understand icing and deicing equipment and know FAR requirements for with "known icing")

Fog and Low Clouds

Define fog and low clouds.

State the three general conditions required for condensation.

State the two methods of reaching saturation.

State how winds aid in the formation of and dissipation of fog and low ceiling clouds.

State the two basic classifications of fog.

State conditions required for the formation or dissipation of the various types of fog.

Define types of inversion, causes, effects on low vis events.

Define the terms: obscuration, partial obscuration and vertical visibility, ceiling, clear, scattered, broken, prevailing visibility, RVR. (include indefinite, overcast and discuss slant range vis experienced by pilots)

State limitations of current/near them forecast/observing systems for detecting/forecasting fog/low clouds.

Understand optical illusion a low vis ops particularly at night or with precipitation understand climatology of fog and low vis events.

From available charts and data determine probability of reduced visibility at destination and alternate.

Describe orographic effects related to cloud formation precipitation, and position of pressure systems and air masses.

Miscellaneous Weather Phenomena

Describe the ITCZ, easterly wave, shear line and polar trough as they affect tropical weather.

State the for the various stages of hurricane formation.

State the latitudes, type of surface (upper air pattern) most conducive for hurricane formation.

State the destructive forces associated with hurricanes.

Describe the types of tornadic activity.(synoptic/mesoscale features associated)

State the method by which tornadoes cause damage.

Describe the various weather warnings. (and the difference between a warning, watch and advisory)

Describe the terrain induced effects on wind, precipitation and cloud formation.

Station Models, Surface Analysis & Surface Prognostic Charts

State the building blocks of surface weather charts.

Identify plotted wind conditions.

Identify plotted weather and visibility.

Identify plotted pressures and temperature.

Identify plotted cloud types.

Identify plotted sky cover.

Determine whether plotted data is forecast or observed.

State the purpose for which a pilot uses a surface analysis chart.

Identify data displayed on surface analysis charts.

State the purpose for which a pilot uses a surface prognostic chart.

Identify data displayed on surface prognostic charts.

Radar Summary Charts Weather Depiction Charts, RAREPS

Determine whether plotted data is observed or forecast.

Identify plotted radar echoes and intensities on radar summary charts.

Identify weather contractions and their accompanying trend symbols on radar summary charts.

Identify echo movements including echo tops and bases on radar summary charts.

Identify indicated severe weather areas on radar summary charts.

Identify two-letter codes used in lieu of radar reports on radar summary charts.

Identify sky coverage symbols plotted on weather depiction chart and weather symbols.

State the definition of a ceiling and how heights are reported.

Identify data plotted around the sky cover symbol and the rules of omission on a weather depiction chart.

State the criteria and methods for plotting areas of IFR/MVFR/VFR on a weather depiction chart.

Understand limitations of weather depict in displaying weather between surface reporting station.

Understand how to obtain, decode, interparet RAREPS and manually digitized data.

Severe Weather Watch Bulletins and Area Forecasts

State the severe weather watch's two-letter teletype identifier.

State the requirements for issuing a severe weather watch.

Read and interpret data on a severe weather watch message.

State the area forecast's two-letter identifier.

Identify valid periods of forecast and outlook.

Understand sections of area forecast and their use (synopsis, hazards, icing, turbulence, clouds and weather)

State the rules of MSL/AGL as they pertain to an area forecast.

Read and interpret displayed data in an area forecast message.

State the wind and visibility rules that apply to an area forecast.

State criteria and content of SIGMETS.

State sources and understand limitations of SIGMET broadcasts.

In-Flight Weather Advisories, Pilot Reports, and CWA

Describe the different types of in-flight weather advisories, how they are disseminated, and their use to pilots (civilian and military)

State the teletype letter identifiers used with in-flight weather advisories.

State the criteria used for issuing each of the in-flight weather advisories.

Read and data displayed in the in-flight weather advisories.

Understand how to obtain and interpret CWA.

State the letter identifiers used with pilot weather reports.

Read and identify data displayed in pilot weather reports and understand how to give one.(and why they are critical to forecasters)

Describe severe weather WATCH and WARNING issued by NWS.

Describe weather ADVISORY and WARNING issued by AWS units.

Understand the importance of pilot weather reports to other pilots, controllers and forecasters.

Winds-Aloft Prognostic Charts, Constant-Pressure Charts and Winds-Aloft Forecasts

State the use of winds-aloft prognostic charts.

State the meaning of valid time on winds-aloft prognostic charts.

Identify plotted data on a winds-aloft prognostic charts.

State the use of a constant-pressure chart.

State the three five levels of constant-pressure charts in millibars and their height in feet.

State the names of the three types of lines drawn on a constant-pressure

Identify data plotted on a constant-pressure chart including the rules for shading in a station model.

State the teletype identifier for a winds-aloft forecast.

Identify coded data in a winds-aloft forecast.

State rules for omissions of temperature and winds in a winds-aloft forecast.

Select a flight altitude from a winds-aloft forecast that results in the most favorable wind component.

Identify tropopause and select alternate altitudes to minimize encountered clear air turbulence (CAT)

Explain how upper air data are collected, and understand the strengths and weaknesses of upper air reports and forecasts.

Aviation Weather Reports

State the letter identifiers used to report various types of aviation weather reports.

State the use of weather observations in flight planning.

Identify the cloud data in weather observations.

Identify the visibility data in weather observations.

Identify the weather and obstructions to vision data in weather observations.

Identify the pressure/altimeter data in weather observations.

Identify the temperature/dew point data in weather observations.

Identify the wind data in weather observations.

Identify the remarks data in weather observations.

Identify data in non standard weather reports (i.e. Mexico, etc.)

Terminal Forecasts

State the use of terminal forecasts in flight planning.

State the two-letter teletype identifier used to identify terminal forecasts.

Identify data in the terminal aerodrome forecast (TAF) code. (and METAR)

Identify data in a U.S. civilian terminal forecast.

State the IFR/VFR rules for flight planning. (for FAR/60-16 and fuel reserves)

State the rules for requirement of an alternate on an IFR flight plan.

Describe which report parameters are reported in AGL and MSL.

NOTAMS

Be familiar with METARS and use.

Flight Weather Briefing (Military Only)

List the three sections of the DD-175-1 which provide space for specific information concerning the three phases of any flight.

State the requirements for completing the takeoff data section of the DD 175-1.

State the first weather source you should check when flight planning including the source of supplemental weather information.

State the teletype/facsimile sources for information on the minimum Ceiling en route.

State the teletype/facsimile sources for information on the maximum cloud tops.

State the teletype/facsimile sources for information on thunderstorm activity en route.

State the teletype/facsimile sources for information on turbulence en route.

State the teletype/facsimile sources for information on icing and the minimum freezing level.

State the teletype/facsimile sources for information on precipitation en route.

State the teletype/facsimile sources for wind aloft and temperature information en route.

FLIGHT WEATHER BRIEFING (Civilian)

State Federal Aviation Regulation (FAR) requirements for preflight briefing.

Understand responsibilities of pilots and dispatchers in determining route, destination and alternate selections based upon weather.

State the primary consideration in selection of a flight level.

Know alternate sources of preflight and enroute update weather (FSS, HIWAS, CWSU etc.)

OTHER INFORMATION (All)

Determine if an alternate is required and state the procedures used to select the best possible alternate.

State with whom the ultimate responsibility for the weather briefing/information gathering prior to each flight belongs.

Understand the methods to collect and receive weather information prior to flight. (including commercial weather data bases)

Identify simple features on a satellite picture. (understand limitations)

NEXRAD and AWDS capabilities and displays.

Pilot's operating in the field for extended periods should have some basic training in observational meteorology (also called single point forecasting and field meteorology)

Understand numerical weather prediction (NWP) and how it is used to derive products.

Understand Circumnavigating thunderstorms using in-flight visual cues.

Understand basic sources of meteorological observations and their limitations (transmissometers, Rawinsonde, LLWAS etc.)

Identify seasonal and climatic weather patterns associated with various regions of the world (international operations only).

Understand fundamental observation techniques/equipment, specialized equipment, specialized equipment (low-level wind shear alert systems, etc.) and radars (weather versus air traffic control), and their relative strengths, weaknesses and capabilities.

Describe the various radar equipment (airborne, ground weather, ground air traffic control), their characteristics (wave length, range, doplar, etc.), their strengths/weaknesses (attenuation, false echoes, etc.) and radar reports (echo intensity, coverage, tops, movement, etc.)

Describe, and know how to calculate, runway crosswind components.

Describe the effects of headwinds, tailwinds, crosswinds and gusts on takeoff and landing, and explain common pilot techniques for dealing with these conditions.

Be able to use all information sources to describe future trends in simple synoptic weather patterns.